AN ANALYSIS OF
MOTION AND TIME STUDY TRAINING
AS GIVEN BY
COLLEGES AND INDUSTRIAL ORGANIZATIONS

A THESIS

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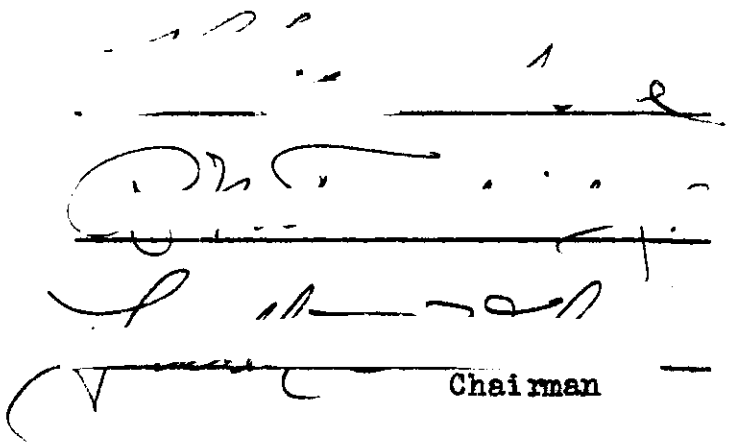

Chairman

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CHAPTER I

INTRODUCTION

The successful application of motion and time study in industrial organizations is dependent on the training of the individuals who apply it.

It has been the purpose of this investigation (1) to ascertain the nature and extent of laboratory training in motion and time study as provided in the colleges and universities of the United States for undergraduate students, and as conducted in leading industrial organizations in the United States, (2) to determine the facilities and equipment used in laboratory training in motion and time study in the colleges and universities and industrial organizations, and (3) to evaluate the procedures of motion and time study laboratory training as given in the United States.

TYPES OF TRAINING

A classification of motion and time study training might be made according to two general types: (1) institutional and (2) industrial. Institutional training is the training given by the colleges and universities, and industrial training is that given by industrial organizations for its employees. Conceivably, a third type might be listed, but it is considered in this study to be essentially the same as

industrial training. This possible third type is the training given especially for industrial organizations by consulting firms or private industrial schools.

A breakdown of institutional training would reveal two main groupings. One of these is the course in motion and time study given for students pursuing a regular course of study for a degree, and the other, given as a public service to people working in industry, includes special courses for which academic prerequisites are not ordinarily required.

Industrial training in motion and time study also is of two general types. The most extensive of these is the training given supervisors, foremen, group leaders, union officials, and other employees. This type of training in motion and time study is usually referred to as "Work Simplification." The purpose of such training is to permit the individual to apply the elementary principles of motion and time study to his job to bring about operating economies. The second type of industrial training is more intensive and is given to the people actively engaged in motion and time study work for the purpose of establishing the best methods of operation and standards of work performance.

IMPORTANCE OF THE STUDY

Training in motion and time study is significantly

important because of the intimate relationship of the subject to all other phases of industrial engineering, such as plant layout, production control, wage incentives, etc. Not only the higher educational institutions but also the industrial organizations of the United States, will find use for the results of this investigation.

Colleges and universities might well use these results as an aid in the design or modification of a motion and time study course or as the basis for evaluating such a course. These results can be used as a guide to determine the curricula that should include motion and time study as a subject; the division or department most suited to offer such a course or courses; the number of courses in which the subject matter should be presented and the amount of credit to be given; the preference for text books for single and multiple term courses; the subjects or activities to be presented in the laboratory, the characteristics of these activities, and time requirements for each of them; and the necessary and desirable equipment and facilities for motion and time study training.

For industrial organizations the results can be used as an aid in evaluating previous training received by an individual and in developing training programs.

The results can also be used as a guide in determining the most desirable content of a text book, laboratory manual, or course syllabus.

SUMMARY OF THESIS

The remainder of this thesis has been divided into seven chapters. Chapter II contains a review of current literature pertaining to the subject, and Chapter III deals with the procedures used in the study. Chapter IV gives comparative information about motion and time study training in colleges and universities; Chapter V is an analysis of campus laboratory procedures used for motion and time study; and Chapter VI is an analysis of the equipment and facilities used in motion and time study instruction. Chapter VII is devoted to motion and time study training as found in industrial organizations. General conclusions comprise the final chapter, Chapter VIII.

CHAPTER II

REVIEW OF THE LITERATURE

Very little information of an analytical nature pertraining to training in motion and time study has been found in contemporary literature. No other study similar in nature to this investigation has been revealed despite diligent search for such a possibility. A search of the literature in the industrial field has disclosed numerous articles and papers dealing with training in motion and time study, but for the most part they consist of descriptions of specific training courses as presented by a college or company.

The incidence of motion and time study as a subject in industrial engineering curricula was shown in the results of a study conducted by Professor James M. Apple, of the Mechanical Engineering Department, Michigan State College.[1] The results of this study were based on the published curricula of colleges offering four year courses in industrial, management, or administrative engineering, and industrial engineering options in mechanical or general engineering. All of the curricula were those accredited by the Engineers' Council for Professional Development. The study showed that

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[1]James M. Apple, "Comparison of Industrial Engineering Curricula," The Journal of Engineering Education (American Society for Engineering Education), 37:821-22, June, 1947.

of the twenty-five colleges that had E. C. P. D. approved curricula, twenty-one, or eighty-four per cent, included motion and time study as a course in the curricula.

Table I, page 7, shows the relative frequency of the courses which were included in the curricula and taught by the industrial engineering department. These figures indicated that motion and time study was the one subject most frequently given in the industrial engineering curriculum, and thus, presumedly, it was considered to be one of the most important.

Evidence of industrial training in motion and time study was shown by the results of an industrial survey given in a leading industrial periodical. The results of this survey were based on the answers given by fifty-one companies engaged in various types of manufacturing in the United States. In answer to the question "In your judgment what is the time required to train the average time study man?"[2] the answers indicated a range from one to sixty months with a mean of 17.6 months.

In still another survey, conducted by Dr. Ralph M. Barnes, the results showed that forty per cent of the people used in time study work were taken from the shop and trained

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[2] M. J. Murphy and R. C. Smith, "How Industry Is Using Time Study and Incentives," Factory Management and Maintenance, 103:111-12, January, 1945.

TABLE I

COURSES OFFERED BY INDUSTRIAL ENGINEERING DEPARTMENTS
OF TWENTY-FIVE COLLEGES
WITH E. C. P. D. APPROVED CURRICULA

	COURSE	No. of Colleges	Per Cent of Total
1.	Motion and Time Study	21	84
2.	Industrial Management	18	72
3.	Accounting	17	68
4.	Industrial Organization	16	64
5.	Personnel Management	14	56
6.	Cost Analysis and Control	14	56
7.	Engineering Economy	13	52
8.	Plant Layout	12	48
9.	Production Control	12	48
10.	Engineering Law	9	36
11.	Marketing	8	32
12.	Management Seminar	7	28
13.	Statistics	7	28
14.	Financial Management	7	28
15.	Tool Engineering	6	24
16.	Safety Engineering	6	24
17.	Materials Handling	5	20
18.	Inspection Trip	5	20
19.	Job Evaluation	4	16
20.	Industrial Surveys	3	12
21.	Quality Control	2	8
22.	Industrial History	2	8
23.	Graphical Presentation	2	8
24.	Budgeting	2	8

Source: James M. Apple, "Comparison of Industrial Engineering Curricula," Journal of Engineering Education, 37:821-22, June, 1947.

for the work, and that forty-two per cent of those doing time study work were college graduates.[3] The results also indicated that the ratio of the number of people doing time study work to the number of people doing methods and layout work was nearly two to one, and that thirty-one of seventy-two companies had conducted training programs in motion and time study for foremen.[4] All of which emphasizes the importance of training individuals who are engaged in this type of work.

Numerous articles and papers have been published describing special courses given by colleges and universities for people regularly employed in industry. Work simplification training programs have also been well described.

Case studies of special industrial courses given by universities have been reported by Professors Marvin E. Mundel[5] and Warren L. Ganong.[6] Each of the training courses was sim-

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[3] Ralph M. Barnes, Industrial Engineering Survey (University of Iowa, College of Engineering, Industrial Engineering Report No. 100, 1948), pp. 14-17.

[4] Ibid., pp. 34-36.

[5] Marvin E. Mundel, "How Industry and Colleges Train Methods Men, Case Study No. 1," Manual of Work Simplification, 1947, (reprints from Factory Management and Maintenance), pp. 17-20.

[6] Warren L. Ganong, "How Industry and Colleges Train Methods Men, Case Study No. 2," Manual of Work Simplification, 1947, (reprints from Factory Management and Maintenance), pp. 20-23.

ilar in that the basic principles of motion and time study were first covered in early sessions of the course, then followed projects in methods improvement. The usual procedure was to have the student select some operation or process in his place of work and subject it to a thorough analysis for the purpose of bringing about improvements.

Perhaps the best known training in motion and time study conducted by a university for people in industry is the summer management course conducted by Barnes at the University of Iowa. In a recent article describing Barnes' work it was stated that

> . . . he has been a vital influence in opening the doors of the university to industry and opening industry's doors to the University. He's been bridging the gap between campus and production line.
>
> Today, at the University's Summer School, he asks each management-student to bring with him a problem in cutting costs. It may be a problem in filing. Or folding paper boxes.
>
> The solution of one such problem is the major project of each student. Under the direction of the course staff they find production short cuts, cost cutters. . .[7]

Training in work simplification has been more widely given in industry because of the greater number of people to whom this type of training is of value. "Work simplifi-

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[7] "Campus Cost-cutting at Work for Industry," Modern Industry, 13:74, June 15, 1947.

cation," as described in the Manual of Work Simplification, "is a broad term used in describing a program whereby a group of people are taught certain principles and techniques which they then apply to their own jobs in order to reduce waste of manpower, materials, and machine capacity."[8] It was further stated in this manual that a typical program contains anywhere from ten to twenty sessions.

Although training in work simplification has been very popular in recent years and especially during World War II, training in time study for these same people has not appeared to have been as frequently given. There were indications that training in time study for this type of employee has received more emphasis in the post-war years. At the 1947 National Time and Motion Study Clinic held in Chicago, a prominent industrial consultant gave the purposes of a training course in time study. He stated that the course was not designed nor intended for use in the training of motion and time study analysts, but that the purpose was to provide

> . . . a simplified program to help executives, supervisors and workers increase their present knowledge on the best Time Study practices and fundamentals, so

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[8] "An Introduction to Work Simplification," Manual of Work Simplification, 1947, (reprints from Factory Management and Maintenance), pp. 9-10.

> they can make the most effective use of their own Plan and can explain its operation to other employees more clearly.[9]

It has been necessary for some companies to train union representatives due to their participation in time study procedures. In one such case the industrial engineer for the company stated that:

> Training is done on the job and after hours. The former is under the supervision of trained time study men. Lectures and training films speed the learning process. After-hours training consists of selected night courses being given at local universities.[10]

In the development of motion and time study men, indications have been that this training has been usually done by the apprenticeship method. Thomas R. Turnbull, a prominent industrial engineer with the Johns-Mansville company, pointed out the hazards of this method when he stated:

> It is certainly dangerous to allow Time Study Trainees to acquire their skill and understanding by Osmosis, from an experienced Time Study man, or through a non-formalized apprenticeship. For, in such instances, the learner is certain to acquire all of the bad practices of the person to whom he

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[9] C. H. Cox, "A New Time Study Training Program for Supervisors," Proceedings National Time and Motion Study Clinic, Chicago, November 5, 6, and 7, 1947, p. 34.

[10] R. T. Walton, "Labor and Management Team Up for Time Studies," Factory Management and Maintenance, 106:75, July, 1948.

> is apprenticed, and there is no way, for either the Manager of the Standards Department or the Management, to be sure that approved Techniques have been acquired.[11]

Phil Carrol, Jr., has also said that ". . . in no case do I agree that a new man should be turned over to an 'old hand' to be trained."[12] Carrol also emphasized the importance of time study training by stating that it is the best means we have in industry today for the development of sound managerial talents, and that time study training is an excellent way to develop management-minded men.[13]

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[11] Thomas R. Turnbull, "Development of a Time Study Training Program," (unpublished paper presented to the Detroit chapter of the Society for the Advancement of Management, April 16, 1946.)

[12] Phil Carrol, Jr., "Training Time Study Men," Modern Management, 6:17, July, 1946.

[13] Loc. cit.

CHAPTER III

PROCEDURE

Results of this investigation have been based on three primary sources of information, all limited to the United States. There were (1) catalogue information of colleges and universities that gave undergraduate training in motion and time study; (2) replies to a questionnaire which was sent to each of these institutions; and (3) replies to a questionnaire submitted to prominent industrial organizations.

The investigation of institutional training was limited to regular academic-credit subjects in motion and time study at the undergraduate level. It was assumed that any special instruction given for people in industry would be basically similar to the other courses given by the institutions since the same instructors and facilities would in all probability be used. Also, the investigation was limited to undergraduate instruction because graduate work in this field is much less extensively done, and when given is usually less standardized and is presented with more pedagogical freedom. For these reasons it was felt that information pertaining to graduate training in motion and time study could not effectively be included in the results.

The investigation of industrial training was limited to formal or classroom training given men who were doing

motion and time study work as their primary duty. Other types of training relating to motion and time study reported by industrial concerns included training in work simplification for people whose duties were not primarily those of motion and time study, and the training of motion and time study men by the apprenticeship method.

Training in work simplification has not been included because such training is ordinarily more superficial than the training given motion and time study men. Review of published articles indicated that training in work simplification was fairly well standardized and reference has previously been made to such courses.[1] Information about the apprenticeship method of training has not been included because of the informal and personal nature of such training.

Details of the procedures used in analysis of existing institutional and industrial training in motion and time study are described in the following pages.

INSTITUTIONAL TRAINING

To make a study of the instructional techniques used by colleges and universities that gave instruction in motion and time study, it was necessary to establish which institutions offered such instruction. Search of educational and

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[1] Cf. ante, p. 10.

other related literature did not reveal any previous study of a similar nature, thus it was necessary to compile a list of such institutions. This list was developed in the following manner:

1. A list of institutions that might have given motion and time study as a subject was compiled from (1) a list of industrial engineering curricula accredited by the Engineers' Council for Professional Development,[2] (2) a list of motion and time study text book adoptions by colleges and universities as obtained from the publishers of these text books, and (3) a review of current literature, educational directories, and organizational membership lists. This list consisted of approximately 150 institutions.

2. Recent catalogues of all the institutions on the list were examined to determine whether any subject or subjects in motion and time study were offered in each of the institutions. This resulted in a reduction to ninety colleges that had curricula leading to a bachelor's degree with indication that motion and time study was a required or an elective subject.

3. A survey of all institutions remaining on the list was made by means of a questionnaire. Samples of the letter

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[2] Fourteenth Annual Report, Engineers' Council for Professional Development, September 30, 1946, p. 24.

and questionnaire that were sent to each institution are shown as Exhibit 1, Appendix B.

4. Replies to the questionnaire reduced the list of institutions to eighty, as some of the replies indicated that motion and time study had not been given at the institution or that it had been discontinued.

The institutions that remained constituted the list that gave motion and time study as a credit subject applicable to a bachelor's degree. This list, with other information is given in Table XVI, Appendix A.

INDUSTRIAL TRAINING

To obtain information pertaining to industrial training in motion and time study a survey was made of prominent industrial organizations in the United States. Samples of the questionnaire and the letter which accompanied it are shown as Exhibit 2, Appendix B.

The fifty-seven companies to whom the questionnaire was sent were selected on the probability that formal or classroom training in motion and time study was given to the men doing this type of work. No attempt was made to determine the extent of this type of training in the country as a whole. The information desired was that relating to the most advanced

form of industrial training, and it was assumed that the larger companies were in better position to supply this information. For these reasons no questionnaires were sent to small companies.

Types of industrial activities engaged in by the companies surveyed included: aeronautical, automotive, construction materials, chemicals, electrical, food, farm equipment, glass, power equipment, retail mail order, non-ferrous metal, office equipment, paper, rubber, steel, and textile.

CHAPTER IV

MOTION AND TIME STUDY INSTRUCTION IN UNIVERSITIES AND COLLEGES

One of the most important phases of instruction in motion and time study is that done at the university or college level. The primary purposes of this training are to familiarize the individual student with the principles and techniques uded in motion and time study to permit the student to understand the subject in its relationship with other subjects, to understand its role in the operation of industrial enterprises, and to help prepare the student for motion and time study or related work upon the completion of his college work. Good training procedures are important to fulfill these purposes.

Comparative information pertaining to institutional instruction in motion and time study is given in this chapter. Results were based on information obtained from recent catalogues of the various colleges and universities and from the replies to the questionnaire that was sent to these institutions. Eighty-nine per cent of the catalogues used as a source of information were for the school years 1947-48 and 1948-49. The oldest catalogues used were for the year 1944-45.

All of the information presented in this chapter is not primarily concerned with instructional techniques or facilities, however it is believed that such information had indirect bearing on the study and was sufficiently important to be included.

RESULTS AND ANALYSIS OF CATALOGUE INFORMATION

Reliability of the List of Institutions That Gave Instruction in Motion and Time Study. The original list of institutions that gave motion and time study instruction consisted of ninety schools. Catalogue information indicated that eighty-three of these schools had some type of a subject devoted to motion and time study. Subjects that were only partially devoted to motion and time study were not considered nor included in the analysis. In addition to the eighty-three institutions, there were seven institutions whose catalogue information did not indicate that motion and time study was given as a subject, but other information indicated that such a subject might have been given. Replies to the questionnaire were received from sixty-three of the eighty-three schools, and no replies were received from the seven. Since these seven institutions did not answer the questionnaire, it has been assumed that they did not offer motion and time study as a subject of instruction. Of the sixty-three responses, representing 76 per cent of the eighty-

three institutions, three of them stated that motion and time study was not offered or that it had been discontinued. This reduced the list to eighty institutions that offered motion and time study as a subject, and replies were received from sixty, or 75 per cent.

With the high percentage of response to the questionnaire and with the catalogue information of the remaining twenty schools, it is believed that the number of eighty represents a reliable figure for the total number of institutions that gave instruction in motion and time study. For this study, it has been assumed that eighty was the total number of institutions that gave instruction in motion and time study in 1948.

Table II, page 21, shows the distribution of the institutions that gave instruction in motion and time study by geographic divisions of the United States. Also shown are the states comprising the various divisions, the number of replies to the questionnaire, and the percentage response in each section.

The greatest response was from the Far Western and Southeastern sections in which 86 and 85 per cent, respectively, of the institutions replied. The sections that gave the smallest responses were the Western and North Central with 67 and 69 per cent, respectively. The response from the North-

TABLE II

GEOGRAPHIC DISTRIBUTION OF INSTITUTIONS
THAT GAVE INSTRUCTION IN MOTION AND TIME STUDY IN 1948,
AND NUMBER OF INSTITUTIONS REPLYING TO QUESTIONNAIRE

	NO. OF INSTITUTIONS	NO. OF REPLIES	PER CENT OF TOTAL
NORTHEASTERN STATES (Del., Conn., Me., Md., Mass., N. H., N. J., N. Y., Pa., R. I., Vt., and D. C.)	25	19	76
NORTH CENTRAL STATES (Ill., Ind., Iowa., Mich., Minn., Mo., Ohio., and Wis.)	26	18	69
SOUTHEASTERN STATES (Ala., Ark., Fla., Ga., Ky., La., Miss., N. Car., S. Car., Tenn., Va., and W. Va.)	13	11	85
WESTERN STATES (Colo., Kans., Nebr., N. Mex., N. Dak., Okla., S. Dak., Texas, and Wyo.)	9	6	67
FAR WESTERN STATES (Ariz., Calif., Idaho, Mont., Nev., Ore., Utah, and Wash.)	7	6	86
UNITED STATES	80	60	75

eastern section was 76 per cent, which was slightly greater than the national response. The number of replies from the various sections was relatively uniform, therefore the results are believed to be representative of each section of the United States as well as the country as a whole.

Geographical Comparison. A geographical comparison of the institutions that gave instruction in motion and time study is shown in Table III, page 23. It is believed that this tabulation shows in some degree the relative quality of instruction for the various sections of the country and for the country as a whole.

Tabulations were based partially on American Society for Engineering Education affiliation because a requirement foraffiliation is that an educational institution engaged in technical instruction have one or more curricula accredited by the Engineers' Council for Professional Development or by a major regional educational association.[1] The accrediting by the Engineers' Council for Professional Development has been on the basis of an inspection upon invitation from the institution desiring the consideration for accrediting.[2]

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[1]"Constitution and By-Laws, American Society for Engineering Education," The Journal of Engineering Education, 38:302, February, 1948.

[2]"E. C. P. D. Resumes Accrediting of Engineering Curricula," The Journal of Engineering Education, 38:209, November, 1947.

TABLE III

GEOGRAPHICAL COMPARISON OF INSTITUTIONS THAT GAVE INSTRUCTION IN MOTION AND TIME STUDY WITH INSTITUTIONS AFFILIATED WITH A. S. E. E. AND INSTITUTIONS WITH E. C. P. D. APPROVED INDUSTRIAL ENGINEERING CURRICULA

		North-eastern	North Central	South-eastern	Western	Far Western	United States
A.	No. of Institutions That Gave M. & T. S. in 1948-----	25	26	13	9	7	80
B.	No. of Institutions Affiliated with A. S. E. E.------	58	31	22	25	18	154
C.	Ratio, Line "A" to Line "B", per Hundred----------	43	84	59	36	39	52
D.	No. of Institutions Affiliated with A. S. E. E. That Gave M. & T. S. in 1948-----	23	22	10	9	7	71
E.	Per Cent, Line "D" of Line "B"----------	40	71	48	36	39	46
F.	Per Cent, Institutions That Gave M. & T. S. That Were Affiliated with A. S. E. E.-	92	85	77	100	100	89
G.	No. of Institutions with E. C. P. D. Approved Industrial Engineering Curricula-	13	5	4	3	1	26
H.	Per Cent, Line "G" of Line "A"----------	52	19	30	33	14	33

NOTES: (1) Source of A. S. E. E. affiliation: B. J. Robertson, "What Do You Know about Your Section," The Journal of Engineering Education, 38:1-6, Feb., 1948.

(2) Source of E. C. P. D. accreditation: Fourteenth Annual Report, Engineers' Council for Professional Development, Sept. 30, 1946, p. 24.

Table III shows that the greatest concentration of institutions that gave instruction in motion and time study in relationship to the institutions that had engineering courses and were affiliated with the A. S. E. E. was in the North Central section of the United States. The ratio of schools that gave training in motion and time study to the total number of schools affiliated with the A. S. E. E. was 84 per hundred. In the Western and Far Western sections, the ratios were 36 and 39 per hundred, respectively, while the ratio of the United States as a whole was 52 per hundred.

Of the institutions that were affiliated with the A. S. E. E. and gave instruction in motion and time study, the North Central sections showed 71 per cent as compared to not more than 48 per cent for any other section. For the United States as a whole, 46 per cent of the institutions that were affiliated with the A. S. E. E. gave instruction in motion and time study.

Of the schools that gave instruction, all of the schools in the Western and Far Western sections were affiliated with the A. S. E. E. The Southeastern sections showed the lowest percentage affiliation with 77 per cent, and the percentage for the United States as a whole was 89.

Comparison of institutions with E. C. P. D. accredited curricula which required motion and time study showed that

the Northeastern section had the greatest percentage of institutions with approved curricula with 52 per cent. For the United States as a whole, 33 per cent of the institutions that required motion and time study had the curricula approved by E. C. P. D.

This information did not show that any one section of the country was outstandingly superior to any other section when A. S. E. E. affiliation and E. C. P. D. accreditation were considered. If any one section appeared to have been superior, it was the Northeastern section as it ranks high in both comparisons. On the basis of E. C. P. D. accreditation alone, which was on individual curricula and not institutional affiliation, the Northeastern section was superior.

Distribution of Institutions by Courses of Study. Information obtained from the catalogues of the eighty institutions that gave instruction in 1948 disclosed that a variety of organized courses of study required motion and time study as a subject. A tabulation of these various courses is shown in Table IV, page 26. Motion and time study was required in fifteen differently named sequences. Of these fifteen, industrial engineering and mechanical engineering options were the designated courses of study in forty-two of the institutions which represented 62.7 per cent of the total number of institutions.

TABLE IV

COURSES OF STUDY THAT REQUIRED
MOTION AND TIME STUDY AS A SUBJECT

	Courses of Study	No. of Colleges	Per Cent of Total	Per Cent, Electives Omitted
1.	Industrial Engineering----------	26	32.50	38.81
2.	Mechanical Engineering Option----	16	20.00	23.89
3.	Industrial Management----------	5	6.25	7.46
4.	Mechanical Engineering----------	4	5.00	5.97
5.	Administrative Engineering-------	3	3.75	4.48
6.	Management Engineering----------	3	3.75	4.48
7.	Production Management----------	2	2.50	2.99
8.	Business Management----------	1	1.25	1.49
9.	Commercial Engineering----------	1	1.25	1.49
10.	Factory Management----------	1	1.25	1.49
11.	General Engineering Option-------	1	1.25	1.49
12.	Engineering and Business Adm.----	1	1.25	1.49
13.	Mechanical Engineering and Busi.-	1	1.25	1.49
14.	Industrial Administration--------	1	1.25	1.49
15.	Management----------	1	1.25	1.49
16.	Elective----------	13	16.25	----
	Total----------	80	100.00	100.00

NOTE: Motion and time study was a required subject in more than one course of study for some institutions. Only the most specialized in industrial engineering subjects was included in this tabulation.

Distribution by Departmental Organization of Institutions That Gave Motion and Time Study Instruction. Catalogue information pertaining to the eighty institutions that gave instruction in motion and time study in 1948 disclosed that in sixty-two of the institutions, the subject was taught by a department in the engineering division of the institution. In the remaining eighteen institutions the instruction was in departments of non-engineering divisions. This information, together with the distribution of institutions by each department, is shown in Table V, page 28. In fifty, or 63 per cent, of the institutions, the industrial and mechanical engineering departments performed the instruction.

Distribution of Institutions by Required and Elected Subjects of a Course of Study. A tabulation of the number of required and elective subjects in motion and time study as given by eighty institutions is shown in Table VI, page 29. This information revealed that in sixty-eight, or 85 per cent, of the institutions, motion and time study was a required subject in some course of study. It also revealed that in fifty-nine, or 73.75 per cent, of the institutions only one subject in motion and time study was given.

Distribution of Sixty-Eight Institutions by Credit Hours Requirement in a Course of Study Leading to a Degree. A tabulation of the sixty-eight institutions that required motion and time study as a subject in a course of study is

TABLE V

ENGINEERING AND NON-ENGINEERING DEPARTMENTS
THAT GAVE MOTION AND TIME STUDY INSTRUCTION

Department	No. of Colleges	Per Cent of Total
ENGINEERING DIVISION:		
Industrial Engineering	26	32.50
Mechanical Engineering	24	30.00
Management Engineering	3	3.75
General Engineering	3	3.75
Administrative Engineering	2	2.50
Industrial Management	1	1.25
Business and Engineering Adm.	1	1.25
Engineering	1	1.25
Shops	1	1.25
Total--	62	77.50
NON-ENGINEERING DIVISIONS:		
Management	6	7.50
Business Administration	5	6.25
Business Management	2	2.50
Business	1	1.25
Business Manufacturing	1	1.25
Commerce	1	1.25
Industry	1	1.25
Industrial Management	1	1.25
Total--	18	22.50
TOTAL	80	100.00

NOTE: Non-engineering divisions included divisions of Commerce, Business, Business Administration, and Business Management.

TABLE VI

TYPES OF MOTION AND TIME STUDY SUBJECTS

M. & T. S. Subjects	No. of Colleges	Per Cent of Total
One Required----------	49	61.25
Two Required----------	12	15.00
Three Required----------	1	1.25
One Required, One Elective---	5	6.25
Two Required, One Elective---	1	1.25
None Required, One Elective--	10	12.50
None Required, Two Electives-	2	2.50
Total---	80	100.00

TABLE VII

HOURS OF CREDIT
FOR REQUIRED MOTION AND TIME STUDY SUBJECTS

Hours Credit Required	No. of Institutions Semester	Quarter
1	1	0
2	10	0
3	24	4
4	7	6
5	1	5
6	2	3
7	2	1
8	0	1
9	0	1
Total	47	21
Mean	3.23 hrs.	4.90 hrs.
Equivalents	4.85 "	3.27 "
Mean, All Inst.	3.24 "	4.86 "

shown in Table VII, page 29. This tabulation revealed that the mean credit hours for all institution was 3.24 semester hours or 4.86 quarter hours. For institutions that operated on the semester basis, the three hour credit subject was in predominance, however for institutions that operated on the quarter basis, no particular hour-subject was shown predominant preference.

RESULTS AND ANALYSIS OF QUESTIONNAIRE REPLIES

Laboratory Training in Motion and Time Study. Replies from the sixty institutions that gave motion and time study indicated that fifty-four, or 85 per cent, of the schools gave laboratory training in motion and time study.

Year Motion and Time Study Was First Given. Of the sixty schools that responded to the questionnaire, fifty-six of them indicated the year that motion and time study theory instruction and laboratory instruction were started. Figure 1, page 31, shows the growth curve for motion and time study instruction based on these fifty-six replies.

The earliest instruction was in 1905, and another institution performed its first instruction in 1908. For the next seventeen years, no additional instruction was started at any other school. From the year 1925 to 1939, the incidence of instruction was rather constant with a total of twenty-five colleges having started instruction by 1939.

Note: Based on replies from 56 colleges of 80 colleges that gave motion and time study instruction in 1948.

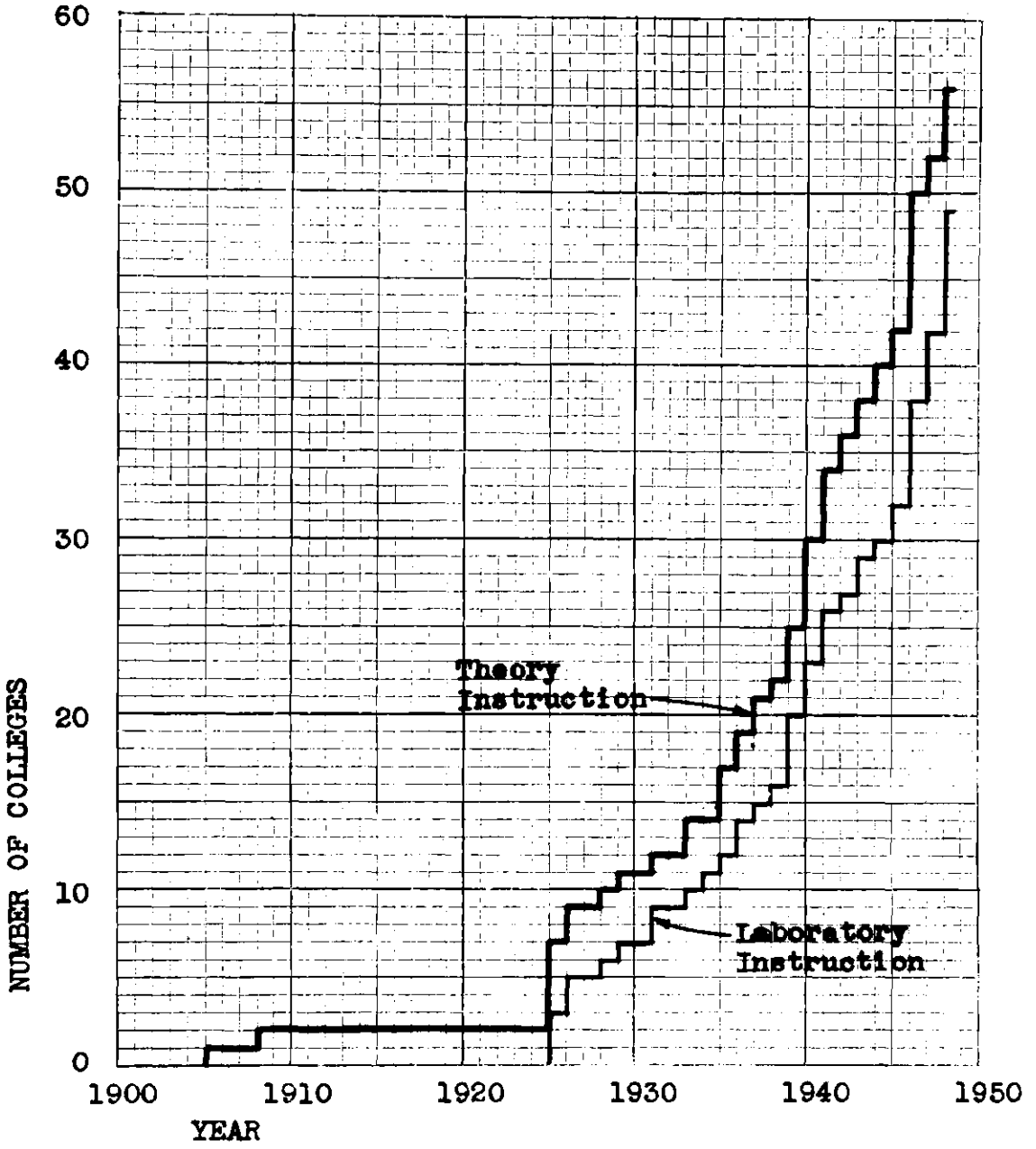

FIGURE 1

GROWTH OF MOTION AND TIME STUDY INSTRUCTION

IN COLLEGES AND UNIVERSITIES

During the years of 1940 and 1941 the growth was accelerated. This coincides with the increased industrial activity associated with World War II when demands were made on schools to help supply technically trained men for industry. From 1942 until the end of the war, the growth was constant at the rate of two new schools each year. In the first year after the war, 1946, eight schools started teaching motion and time study, and this coincides with the general increase in enrollment at colleges and universities following the war. Since the war, the growth in instruction has continued through the year 1948, and the curve shows no indication of leveling off.

The growth curve as shown in Figure 1 does not give a complete record of the growth of motion and time study instruction in colleges and universities due to lack of complete data from all schools that gave motion and time study instruction. It has been estimated that there was a total of eighty schools that gave instruction in motion and time study as a separate subject. The curve was based on replies from fifty-six schools. Of these fifty-six schools, the replies from seven institutions indicated the probable date for the beginning of this instruction with the possibility of it having been started earlier. Of twenty schools not included in the data, seven schools had E. C. P. D. approved industrial engineering curricula. It was probable that these seven schools gave motion and time study instruction prior to 1941

since most of the E. C. P. D. accrediting was done prior to World War II.[3] The growth of motion and time study instruction as shown in Figure 1 indicated the trend of the growth based on available information, and it is believed that the true curve would terminate approximately twenty-five points higher for the year 1948.

Industrial Training in Motion and Time Study. Of the sixty respondents to the questionnaire, thirty-one, or 52 percent, indicated that industrial training in motion and time study had been given during or previous to 1948. Results of industrial training in motion and time study are shown in Table VIII, page 34.

Of these thirty-one schools, only fourteen, or 45.2 per cent, of those that had given industrial training, gave such training in either 1947 or 1948. The influence of World War II on motion and time study training was evident in that seventeen schools, or 54.8 per cent, of those that had given industrial training gave such training only during the years 1941 through 1946.

Of the schools that have given industrial training, seventeen, or 54.9 per cent, had motion and time study as a curriculum subject prior to 1940, and of the fourteen schools

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[3] "E. C. P. D. Resumes Accrediting of Engineering Corricula," loc. cit.

TABLE VIII

SPECIAL TRAINING IN MOTION AND TIME STUDY
AS GIVEN BY COLLEGES FOR INDUSTRY--
COMPARED BY YEARS WHEN GIVEN

When Instruction Was First Given	No. of Colleges, Total		Instruction Given in War Years 1941-1946		Instruction Given in Post-war Years 1947-1948	
	No.	%	No.	%	No.	%
Before 1940----	17	55	8	26	9	29
Since 1940-----	12	39	8	26	4	13
Not Known------	2	6	1	3	1	3
Total------	31	100	17	55	14	45

NOTE: Based on a total of sixty questionnaire replies. Thirty-one colleges, or 52 per cent, had given industrial training in motion and time study, and twenty-nine colleges, or 48 per cent, had not given such training.

which gave industrial training in 1947 and 1948, nine of these schools had motion and time study as a curriculum subject before 1940. Four of the fourteen had offered motion and time study as a curriculum subject since 1940.

Replies to this particular question indicated that industrial training in motion and time study was done by the schools more experienced in giving instruction in motion and time study.

Number of Students Instructed Per Year. Replies from sixty institutions that gave instruction in motion and time study gave information pertaining to the approximate number of students trained in motion and time study each year. A tabulation of this information is shown in Table IX, page 36. For thirty-eight, or 63.4 per cent, of the institutions the total number of students taught in each institution was less than one hundred. Large groups have not been given instruction except in several institutions. The number of institutions that gave training to more than two hundred students per year was nine, or 15 per cent, and the total number of students trained in motion and time study per year was approximately 6900 students. The nine schools that each gave instruction to two hundred or more students per year instruct approximately 2900 students, or 42 per cent of the total

Text Books Used. Fifty-six institutions indicated the text book that was used in sixty-eight classes in motion and time study taught by these institutions. The distribution of the sixty-eight classes by text book name and author is shown

TABLE IX

YEARLY ENROLLMENT
IN MOTION AND TIME STUDY SUBJECTS

Number of Students Per Year	Number of Institutions	Per Cent of Total
0 to 50	16	26.7
51 to 100	22	36.6
101 to 150	7	11.7
151 to 200	6	10.0
201 to 250	2	3.3
251 to 300	4	6.7
301 to 350	0	---
351 to 400	1	1.7
More than 400	2	3.3
Total--	60	100.0

in Table X, page 38. A total of thirteen different texts were used, however four texts were used for nearly 83 per cent of the total number. The most frequently used text, Barnes' Motion and Time Study,[4] was used in more than 43 per cent of the classes which was double the percentage for any other single book.

A comparison of texts used in a second subject of instruction in motion and time study showed that a total of seven texts were indicated as having been used. This comparison for a second subject showed that there was not a decided preference for any one text as there was when all courses were considered. This may indicate that an advanced text in motion and time study is needed, or that advanced treatment of the subject cannot easily be presented in a book.

Use of Laboratory Manuals. Although 88 per cent of the institutions that gave instruction in motion and time study also gave laboratory instruction, information from fifty-four institutions did not indicate that there was any extensive use of laboratory manuals in the laboratory phase of instruction. The extent of use of laboratory manuals is shown in Table XI, page 39. Thirty institutions, or 55 per cent, indicated that no manual was used. There was no preference for any particular manual by those institutions that

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[4]Publisher, John Wiley and Sons, Inc., New York, 1940, 2nd.ed.

TABLE X

TEXT BOOKS USED BY COLLEGES IN MOTION AND TIME STUDY INSTRUCTION

I. Sixty-eight courses in motion and time study as given at fifty-six colleges.
II. Twelve courses in motion and time study given as a second subject at twelve colleges.

	I		II	
	No. of Courses	Per Cent of Total	No. of Courses	Per Cent of Total
Barnes, Motion and Time Study (27, 4/2, 1/3)--	29 1/3	43.2	2	16.7
Lowry, Maynard, and Stegemerten, Time and Motion Study (13, 2/2, 1/3)----------	14 1/3	21.1	3	25.0
Morrow, Time Study and Motion Economy--------	8	11.8	1	8.3
Mundel, Systematic Motion and Time Study-	4 1/2	6.6	1 1/2	12.5
Instructors' Notes, No Text Used----------	3	4.4	2	16.7
Barnes, Work Methods Training Manual-------	1 1/2	2.2		
Schutt, Time Study Engineering-----------	1 1/2	2.2		
Maynard and Stegemerten, Operation Analysis----	1 1/3	1.9		
Holmes, Applied Time and Motion Study------	1	1.5	1	8.3
Shumard, Primer of Time Study------------	1	1.5	1	8.3
Alford and Bangs, Production Hand Book--	1	1.5		
Barnes, Motion and Time Study Applications----	1/2	.7		
Maynard, Stegemerten, and Schwab, Methods Time Measurement------	1/2	.7	1/2	4.2
Sampter, Motion Study----------	1/2	.7		
Total----	68	100.0	12	100.0

NOTE: Fractions indicate that more than one text was used for a subject.

TABLE XI

LABORATORY MANUALS USED IN
MOTION AND TIME STUDY INSTRUCTION

	No. of Colleges	Per Cent of Total
No Manual Indicated----------	30	55
Institutional Manual or Notes	15	27
Barnes, Motion and Time Study Applications---------	2 1/2	5
University of Michigan-------	2	4
Barnes, Work Measurement Manual----------	1 1/2	3
Barnes, (Unspecified)--------	2	4
Private Companies' Procedures Manual----------	1	2
Total------	54	100

NOTES: Fractions indicate that more than one manual was used.

A manual was considered to be institutional if used only at the institution where it was written.

indicated that a manual was used.

The situation as revealed by this information was contrastingly different than the situation for laboratory instruction in another branch of engineering. A study of the use of laboratory manuals in electrical engineering laboratory instruction showed that nearly all of the institutions used manuals, and as many as 92 per cent of the manuals in certain courses were prepared by someone in the school that gave the instruction.[5]

The manuals that were used by more than one institution for motion and time study were not conventional laboratory manuals with perhaps the exception of the one designated as "University of Michigan." The publications by Barnes were essentially supplementary text material rather than being laboratory manuals. Several of the colleges that used their own manual or notes submitted samples for inspection. These usually consisted of specific laboratory instructions and exercises and could be considered conventional manuals. One published manual was Motion and Time Study Laboratory Manual by Harold E. Smalley,[6] however results

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[5]Joseph C. Michalowicz, "Electrical Engineering Laboratory Exercises," The Journal of Engineering Education (American Society for Engineering Education), 38:766, June, 1948.

[6]Publisher, Wm. C. Brown Company, Dubugue, Iowa, 1948.

indicate that it has not at present a wide usage.

SUMMARY OF CONCLUSIONS

Partial conclusions pertaining to instruction in motion and time study given by colleges and universities are summarized as follows:

1. Extent of instruction in motion and time study was influenced by the degree of industrialization in the sections of the United States since the Northeastern and North Central sections gave the predominance of instruction.

2. The general quality of instruction in motion and time study was highest in the Northeastern section of the United States if E. C. P. D. accreditation is used as the criterion.

3. The most common courses of study that included motion and time study as a required course were industrial engineering and industrial options in mechanical engineering.

4. Motion and time study was primarily an engineering subject, however, it was not strictly an engineering subject as it was frequently taught in connection with business courses.

5. Motion and time study was usually given as a single required subject in a course of study. It was frequently given as two subjects with motion study as one subject and time study as the other.

6. The extent of instruction in motion and time study has experienced a steady growth since 1925 with an acceleration at the beginning and end of World War II. There was no evidence to indicate that the growth had stopped as of 1948.

7. Special industrial training in motion and time study was accelerated during World War II and has since declined, especially at institutions where instruction in motion and time study was given for the first time since 1940.

8. There was a decided preference for Barnes' Motion and Time Study[7] as the text for subjects in motion and time study with Lowry, Maynard, and Stegemerten's Time and Motion Study,[8] Morrow's Time Study and Motion Economy,[9] and Mundel's Systematic Time Study[10] preferred in the order given.

9. There was no decided preference for any particular text for a second or advanced course in motion and time study.

10. The use of laboratory manuals for motion and time study instruction has not been a common practice. It is believed that this condition existed because the subject matter can be effectively presented without a manual, or a suitable manual for use in the laboratory has not been published.

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[7]Publisher, John Wiley and Sons, Inc., New York, 1940, 2nd.ed.

[8]Publisher, McGraw-Hill Book Company, Inc., New York, 1940, 3rd.ed.

[9]Publisher, The Ronald Press Company, New York, 1946.

[10]Publisher, Prentice Hall, Inc., New York, 1947.

CHAPTER V

ANALYSIS OF MOTION AND TIME STUDY LABORATORY PROCEDURES

Numerous variations have existed in motion and time study laboratory procedures due to the influence of many factors, some of which have been presented in the preceding chapter. Such variations have not permitted the presentation of a complete picture of laboratory procedures. However, it has been possible to classify laboratory activities at many of the colleges, a tabulation of which gave a cross-sectional presentation of laboratory procedures. These activities are shown in Figure 2, pages 44 through 48, and are presented as typical laboratory activities in motion and time study.

This figure shows the number of institutions that used each of the activities in laboratory training and the average number of laboratory periods that were devoted to each activity. These results were based on information received from twenty institutions that gave a single course in motion and time study with a laboratory period consisting of two or three hours per week, and from ten institutions that had a laboratory period of six hours per week or that gave motion and time study as two courses. This breakdown gave a representation of "normal" and "intensive" laboratory training.

KEY

"NORMAL" LABORATORY TRAINING:

1st Bar--Percentage and number of institutions that indicated primary use of the activity in laboratory instruction given once a week in a two or a three hour period. Based on activities at twenty colleges.

2nd Bar--Average number of laboratory periods devoted to the activity by institutions represented in 1st bar.

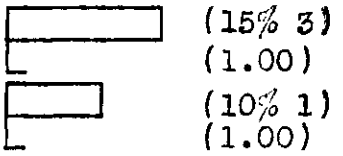
"INTENSIVE" LABORATORY TRAINING:

3rd Bar--Percentage and number of institutions that indicated primary use of the activity in laboratory instruction given as two subjects or as a five or six hour period per week. Based on activities at ten colleges.

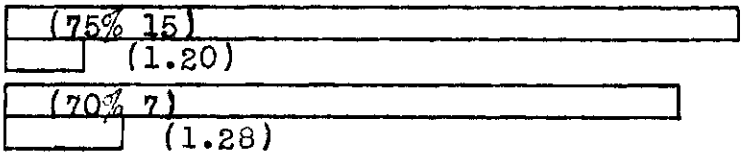
4th Bar--Average number of laboratory periods devoted to the activity by institutions represented in 3rd bar.

ACTIVITY

1. Demonstration:



2. Stop Watch Practice:



3. Process Charts:

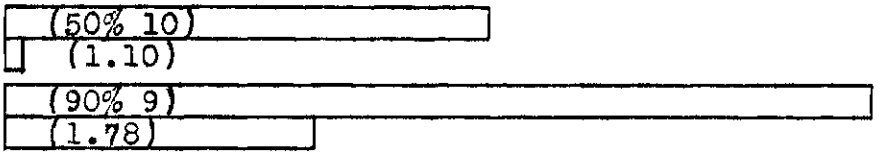
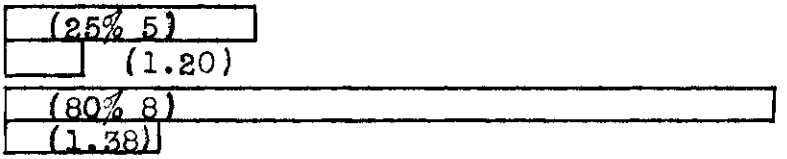


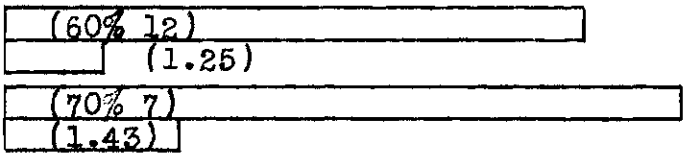
FIGURE 2

COMPARISON OF LABORATORY ACTIVITIES
IN MOTION AND TIME STUDY

4. Man and Machine Charts:

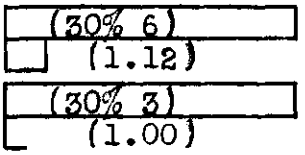


5. Left and Right Hand Charts:

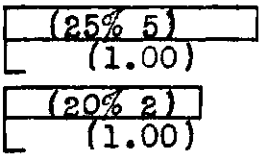


6. Micromotion Study:

7. Motion Picture Photography:



8. Motion Pictures Shown:



9. Principles of Motion Economy:

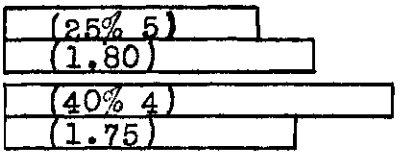
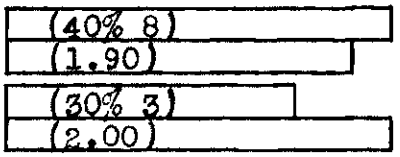


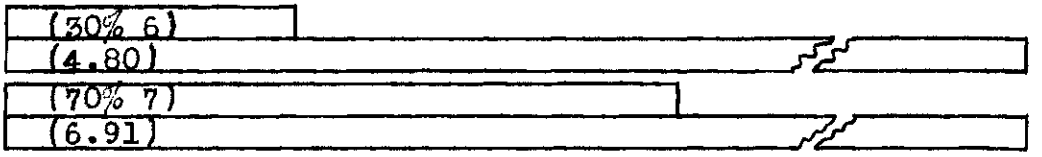
FIGURE 2 (Continued)

COMPARISON OF LABORATORY ACTIVITIES
IN MOTION AND TIME STUDY

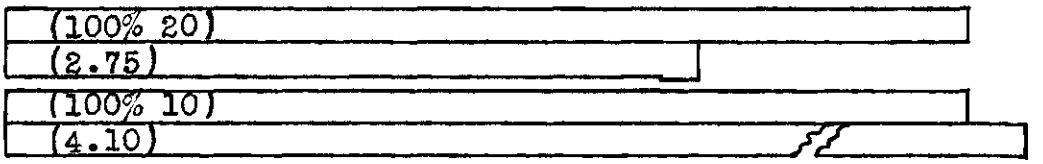
10. Operation Analysis:



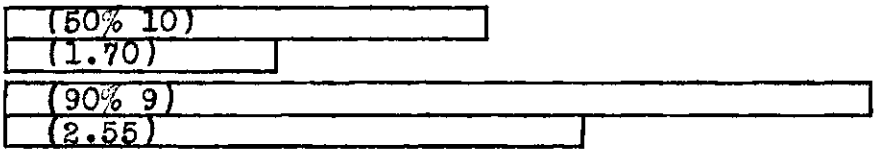
11. Methods Project:



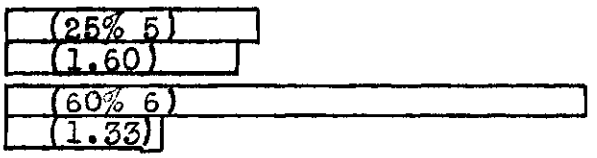
12. Time Study:



13. Performance Rating:



14. Motion Time Data:



15. Standard Data:

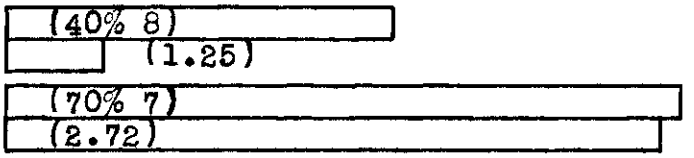
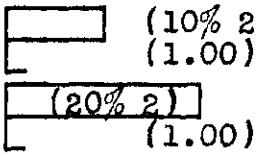


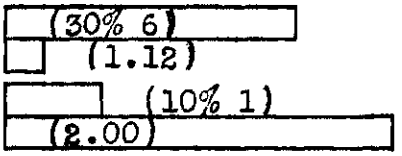
FIGURE 2 (Continued)

COMPARISON OF LABORATORY ACTIVITIES
IN MOTION AND TIME STUDY

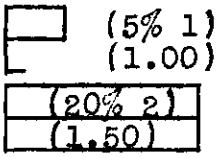
16. Allowance Determination:



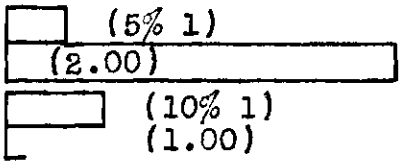
17. Plant Visits:



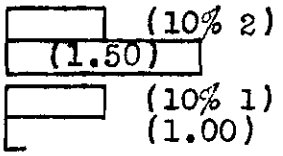
18. Employee Training:



19. Problem Solution:



20. Discussion:



21. Miscellaneous:

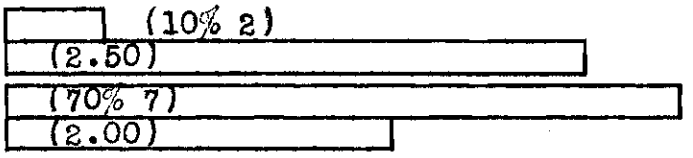
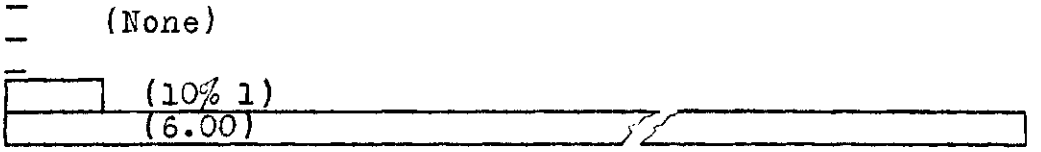


FIGURE 2 (Continued)

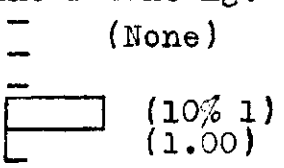
COMPARISON OF LABORATORY ACTIVITIES
IN MOTION AND TIME STUDY

22. Written Standard Practice:

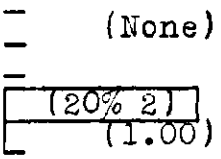
23. Industrial Time Study:



24. Line Balancing:



25. Ratio Delay:



26. Interference:

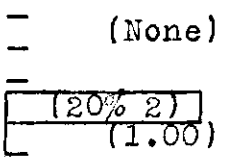


FIGURE 2 (Continued)

COMPARISON OF LABORATORY ACTIVITIES
IN MOTION AND TIME STUDY

Each of the major activities is discussed separately in this chapter relative to (1) the definition, (2) extent of use, (3) combination with other activities, and (4) techniques and facilities used in the presentation of the activity.

ANALYSIS OF LABORATORY ACTIVITY

Demonstration

Definition: By demonstrations it was meant that the laboratory period was used by the instructor to demonstrate some general principle of motion and time study with little or no participation by the student.

Purpose: Generally, the demonstration was for inspirational purposes, such as pointing out the effectiveness of motion and time study applications. Not included in this classification were specific demonstrations such as might be used for instruction in motion picture photography or specific principles of motion economy. If the primary purpose was interpreted to be one of another activity classification, it was so classified.

Extent of Use: Demonstrations as a technique were used infrequently by either the institutions that gave normal or intensive laboratory instruction. Of the institutions that did use demonstrations, they were only to a minor extent as it was indicated that an average of one laboratory period was used.

Combination: Other techniques, such as stop watch timing by the student, were combined with the demonstration for emphasis. Numerous other types of laboratory activities were presented by means of demonstrations.

Technique and Facilities: Most frequently, some type of an operation was performed using an unimproved method. In contrast, an improved method was presented which illustrated the effects of methods improvement. An operation frequently used for this was Barnes' Pin Board assembly.[1]

Stop Watch Practice

Definition: By stop watch practice it was meant that the laboratory period was devoted to instructing the student in the use of a stop watch by means of a timing exercise.

Purpose: The purpose of stop watch practice was to permit the student to gain elementary skill in making a time observation using a stop watch.

Extent of Use: The activity of stop watch practice was extensively used by institutions giving both normal and intensive laboratory instruction. Usually, one period sufficed for this instruction, however in some schools it was extended beyond one period.

Combination: Stop watch practice was frequently combined with another activity such as a demonstration, process

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[1] Ralph M. Barnes, Work Methods Manual (New York: John Wiley and Sons, Inc., 1944), pp. 62-65.

chart, man and machine chart, left and right hand operation chart, and others.

Technique and Facilities: Stop watch practice was most usually done by having the student time some type of an operation. The operation was performed by the instructor or by one of the students in the laboratory, or operations outside the laboratory were sometimes used. Special devices used were a time study training board and motion pictures. The time study training board consisted of several visual indicators, usually differently colored lights, and several audible indicators, such as a bell and buzzer. By means of separate control switches, the audible or visual indicators were activated for definite increments of time and in some specific sequence. The student timed the various elements, the results of which were compared to the original for accuracy. Motion pictures were also used to project operations or events which were timed by the student. The speed of projection would be varied to require faster stop watch readings by the observer.

Process Charts

Definition: Process charts pertained to the activity of recording a series of events and other relative information for analysis of the process. It included multiple-item processes which required combinations or assemblies, single items which required processing, and an individual's actions in the performance of a job. It also included flow diagrams.

Purpose: The purpose of this activity was to train the student in the mechanics of preparing a process chart and to understand its analysis and application.

Extent of Use: The activity of process charting was used to greater extent by institutions giving intensive laboratory training than those giving normal training. Indications were that more than 50 per cent of all institutions used this activity. Institutions with normal trainingdid not extend the activity much past one period, whereas institutions with intensive training extended it slightly.

Combination: Process charting was combined with other activities, most notable of which was operation analysis for methods improvement.

Techniques and Facilities: Some type of a process or activity was observed by the students to obtain the necessary information to prepare a process chart. This process might have been some activity on the college campus, a non-industrial process off the campus, an industrial process in a plant, a simulated process in the laboratory, or an industrial process shown by means of motion pictures. It was common procedure to have the student analyze the process and make recommendations for improvement.

Man and Machine Chart

Definition: The man and machine chart activity consisted of recording the necessary information and the pre-

paration of a chart showing the parallel activities, usually to a time scale, of such activities as a man and a machine, a man and several machines, several men working as a group, etc.

Purpose: The purpose of this activity was to train the student in the method of preparing a man and machine chart and to understand its analysis and application.

Extent of Use: The man and machine chart activity was used to a less degree by the institutions that gave normal laboratory training than those that gave intensive training. Twenty-five per cent of the former and 80 per cent of the latter indicated that this activity was used. For either type of institution the time devoted to the activity was limited to one laboratory period.

Combination: The man and machine chart activity was frequently combined with other activities, principally operation analysis and time study.

Technique and Facilities: An operation involving the use of one or more machines was observed and information obtained to enable the student to prepare a man and machine chart for analysis. The student's recommendations for improvement were usually required. An industrial operation was simulated in the laboratory or in the school shops to provide the subject for observation. Motion pictures were also used to provide the necessary operation.

Left and Right Hand Chart

Definition: The left and right hand chart was the activity of observing an operation and the preparation of a left and right hand operations chart for analysis purposes.

Purpose: The purpose of this activity was to train the student in the method of preparing a left and right hand operations chart and to understand its analysis and application.

Extent of Use: The left and right hand chart was used as a laboratory activity very frequently by all institutions included in the analysis. Results showed that 60 per cent of the institutions that gave normal laboratory training and 70 per cent of those that gave intensive training included this activity. Time spent on this activity was between one and two periods.

Combination: The left and right hand chart was frequently combined with other activities, especially time study.

Technique and Facilities: To provide the subject matter for observation, an assembly operation or a machine operation was performed by the instructor or student. Either a gross or detailed breakdown of the operation was required, together with recommendations for improvements.

Micromotion Study

Definition: Micromotion study consisted of the analysis of a motion picture of an operation by therbligs and the prep-

aration of a simultaneous motion chart for analysis.

Purpose: It was the purpose of this activity to train the student in the techniques of motion picture analysis and the preparation of a simultaneous motion chart.

Extent of Use: Micromotion study was extensively used by institutions that gave laboratory training. Sixty per cent of the institutions that gave normal training and 80 per cent of the institutions that gave intensive training used this activity. The number of laboratory periods devoted to it ranged between 1 1/2 and 1 2/3 periods.

Combination: Micromotion study was not combined with other activities to any noticeable extent except methods projects.

Technique and Facilities: Micromotion study was done in the laboratory using motion picture films of operations as the subject of analysis. The films were prepared in the laboratory by previous classes or special films for analysis were used. Special motion picture projectors, hand-crank projectors, and editor-viewers were used in making the analysis.

Motion Picture Photography

Definition: The activity of motion picture photography applied to the laboratory periods in which instruction or practice in making motion pictures was predominant. It did not include the making of motion pictures in connection

with a methods project.

Purpose: The purpose of the activity, motion picture photography, was to give the student training in making motion pictures and to permit the student to become familiar with photographic equipment.

Extent of Use: The use of laboratory time for instruction in motion picture photography was indicated by 30 per cent of the institutions, and an average of one period was used for this instruction.

Combination: Motion picture photography instruction was not combined with other activities except methods projects.

Motion Pictures Shown

Definition: The term "motion pictures shown" was used to designate the laboratory periods that were used for the showing of motion pictures. Usually, the pictures shown were of an inspirational nature or pertained to a specific subject.

Purpose: The purpose of this activity was to instruct or demonstrate some principle or technique of motion and time study.

Extent of Use: Motion pictures, as the predominant laboratory activity, were used by not more than 25 per cent of the institutions.

Combination: Motion pictures were frequently shown in combination with all other laboratory activities.

Principles of Motion Economy

Definition: The laboratory activity, the principles of motion economy, were those sessions devoted to the principles or rules which make manual work more effective when applied.

Purpose: It was the purpose of this activity to demonstrate, verify, evaluate, or apply the principles of motion economy.

Extent of Use: This activity was used only occasionally as results indicated that from 25 to 40 per cent of the colleges had an activity of this nature. Schools with the more intense instruction made greater use of it than those with normal instruction. The average number of periods used was approximately 1.75.

Combination: The activity was frequently combined with many of the other laboratory activities, especially those pertaining to motion study.

Technique and Facilities: Several methods were used to present this activity in the laboratory. Among these were demonstrations using special assemblies, fixtures, tools, etc.; comparative analysis or timing of situations in which one or several of the principles were and were not applied; and use of check-sheets to rate operations, presented by means of motion pictures, on the extent of application of the principles.

Operation Analysis

Definition: Operation analysis pertained to the laboratory sessions which were devoted to the analysis and the preparation of recommended improvements of an operation in which the techniques of analysis were not restricted.

Purpose: The purpose of this activity was to permit the student to apply the various techniques of analysis and to show originality, judgment, and skill in the recommendations for improvements.

Extent of Use: Institutions with normal laboratory training indicated that it was used in 40 per cent of the schools, whereas those with more intensive training indicated that the use was 30 per cent. For both types of schools, an average of approximately two periods were devoted to this activity.

Combination: Operation analysis was combined with other activities, especially time study.

Technique and Facilities: Some type of an operation, either simulated or actual, was observed and analyzed by the student. Usually, one laboratory period was required for each analysis, thus several analyses covering different types of operations were included in the laboratory training. Improvements were not actually developed, only recommended.

Methods Project

Definition: By methods project it was meant that an

original problem was used for a series of analyses.

Purpose: The purpose of the methods project was to give the student an opportunity to apply the techniques of motion and time study to an actual or simulated situation to permit him to show originality, judgment, and skill in the application of the techniques to bring about an improvement in the operation.

Extent of Use: The methods project was used by 70 per cent of the schools that gave intensive laboratory instruction, but only 30 per cent of the schools that gave the normal laboratory instruction used this activity. It is believed that this pronounced difference can be attributed to the fewer laboratory periods available for a project at the colleges where normal training was given. The average number of periods required for methods projects was nearly five for schools giving normal training and nearly seven for schools giving the more intensive training.

Combination: Practically all other activities were combined with the methods project. Among these were process charts, man and machine charts, left and right hand operations charts, motion picture photography, micromotion study, principles of motion economy, and time study. Other procedures or practices not listed as an activity were also combined with the methods project. Among these were standard procedures, instruction sheets, cost estimates, cost reduction reports,

tool design, and others.

Technique and Facilities: An operation, either an assembly or one involving a machine, was selected by a group of several students for detailed analysis to permit the development of an improved operation. The work was done either in the laboratory or the school's shops using an operation that simulated an industrial problem, or an actual industrial operation was selected in some firm, and the analysis and improvements were done off the campus. A characteristic of the methods project that was not a part of the operation analysis activity was the actual development of the improved method which permitted actual comparisons between the unimproved and improved situations rather than an estimate of these differences.

Time Study

Definition: The term "time study" applied to the laboratory activities pertaining to the techniques of making a time study observation for rate setting purposes. It did not include stop watch practice as previously defined, nor did it apply to periods which were specifically devoted to a particular phase of time study, such as the determination of allowances.

Purpose: The purpose of time study was to train the student in the techniques and procedures of making a time study observation using a stop watch.

Extent of Use: All institutions that gave normal and intensive laboratory training indicated that laboratory periods were used for time study purposes. The schools giving the intensive training used nearly seven periods, on the average, for this activity, while the schools that gave normal training used nearly three periods. The difference in the time available was very noticable in the extent of time devoted to the activity between the two types of schools.

Combination: Other activities were frequently combined with time study. Among these were the various types of process charts, operation analysis, methods project, performance rating, standard data, and allowance determination.

Technique and Facilities: The students were required to make time study observations in varying degrees of completion. The operations used for the purpose were usually simulated industrial operations performed in the laboratory or the school's shops. Assemblies and machine operations were commonly used. In some cases the observations were made in industrial plants. Since several laboratory periods were usually used for this activity, the student had the opportunity to make a completely detailed time study to determine the performance standard for the operation.

Performance Rating

Definition: The activity of performance rating pertained to the technique used in time study of evaluating or

judging the effectiveness of a performance during an observation.

Purpose: The purpose of performance rating was to familiarize the student with the various methods of rating, to establish a concept of a normal performance and the variations from normal, and to develop an elementary skill in the ability to rate a performance.

Extent of Use: Fifty per cent of the schools that gave normal laboratory training and 90 per cent of the schools that gave intensive training used this activity as part of the laboratory training. The number of periods devoted to it averaged 2.55 for schools giving intensive training and 1.70 for schools giving normal training. This indicated that the schools that gave the more intensive training emphasized performance rating, as they did time study, to a greater extent than did the schools that gave normal laboratory training.

Technique and Facilities: Laboratory instruction in performance rating was done by using common operations such as card dealing and walking; special assemblies such as the pin board assembly[2] and others; specially prepared motion picture films; and actual industrial operations.

Motion Time Data

Definition: Motion time data applied to the application

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[2]Barnes, loc. cit.

of standard motion time data in determining a standard time for an operation.

Purpose: The purpose of this activity was to instruct the student in the methods of application of motion time data.

Extent of Use: Application of motion time data was used by 60 per cent of the schools giving intensive training and 25 per cent of the schools giving normal training. This difference indicated that motion time data application was a phase of motion and time study which was considered to be more advanced in nature than some of the other subjects. The number of laboratory periods used for this activity was slightly more than one period.

Standard Data

Definition: The term "standard data" applied to those laboratory periods that were used for the development of elemental standard data, which included tables, curves, and formulae, and the application of elemental standard data.

Purpose: The purpose of standard data was to instruct the student in the methods of developing and applying standard data.

Extent of Use: Forty per cent of the institutions that gave normal laboratory training and 70 per cent of the institutions that gave intensive training included standard data as one of the laboratory activities. The difference in this extent of use indicates that this subject was one of an advanced

nature. The number of laboratory periods used was nearly three for the schools giving the more intense training as compared to slightly more than one period for schools giving normal training.

Technique and Facilities: When the activity was limited to application, prepared standard data were given the student to be applied in determining the standard time to perform an operation. When used in this manner it was essentially a supervised or controlled solution of a comprehensive problem. In other institutions a series of completed time studies were given the student from which he developed the standard data and made application of it in determining the time standard for operations. In still other institutions a series of time study observations were required to be made by the student to obtain the information from which the standard data were developed. The number of periods used for this activity was dependent on the technique used in presentation. In at least one institution (not included in the tabulation) the advanced undergraduate course in motion and time study consisted entirely of the development of standard data.

Operations used for standard data development were usually machining or processing operations performed in the laboratory or the school shops. In some cases assembly or packaging operations were used.

Miscellaneous Activities

The remaining activities that were tabulated did not occur frequently enough to warrant a separate analysis of each, however some of them are of sufficient importance to require some discussion.

Plant visits were occasionally made a part of motion and time study laboratory training. It was usually required of the student while making the plant visit to observe and analyze certain processes and operations. A written report, perhaps with recommendations for improvements, was then required of the student. At one institution the student met with the plant managers in a conference for a discussion and presentation of the analysis.[3]

Miscellaneous activities consisted of the laboratory periods which were used for subjects not directly associated with motion and time study such as wage incentives, job evaluation, dexterity tests, etc.

In the tabulation of the activities for institutions giving intensive laboratory training, the activities of industrial time study, line balancing, ratio delay study, and interference did not occur as an activity for the institutions that gave normal training. All of these were evidently subjects and activities of more advanced training. The activity of

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[3]Louis E. Davis, "How U.C. Students Study and Analyze Industrial Plants," Pacific Factory, 70:56, Nov., 1948.

industrial time study was reported by one institution. In this activity the student was sent into an industrial plant for six laboratory periods during which time he made time study observations of actual industrial operations. Another institution, not included in the tabulation, had a second course in motion and time study which consisted entirely of in-the-plant time study observation. Conferences, discussions, and reports were required of the student.

SUMMARY OF ANALYSIS AND CONCLUSIONS

Extent of Use of Laboratory Activities

The laboratory activities which were most extensively used by the thirty institutions included in the tabulation were stop watch practice, process charts, man and machine charts, micromotion study, operation analysis, methods project, time study, performance rating, motion time data, and standard data. Of these activities, man and machine charts, methods projects, performance rating, motion time data, and standard data were used less frequently by institutions that gave normal laboratory training than institutions that gave intense training. Laboratory activities which were not extensively but frequently used were motion picture photography, motion pictures shown, principles of motion economy, operation analysis, and plant visits. The remaining activities of problem solution, employee training,

allowance determination, and discussion were infrequently used by either the institution that gave normal or intensive training. The activity of written standard practice was used by one institution that gave normal training and by none of the schools that gave intensive training. The activities of industrial time study, line balancing, ratio delay study, and interference were given infrequently by schools that gave intensive training and not at all by schools that gave normal training.

The emphasis as indicated by the number of laboratory periods devoted to the various activities was on methods project, time study, performance rating, and standard data. More than one laboratory period was usually devoted to these activities. The schools that gave more intensive training devoted more time to nearly all activities than did the schools that gave only normal training.

No tabulation was shown which indicated the relative emphasis on motion study and time study when considered as separate subjects. This was not done because of combinations of activities and lack of information relative to theory instruction. However, from the available information it appeared as though the emphasis was equally distributed between the two subjects, or that motion study was emphasized only slightly more than time study.

It is felt that the results presented in Figure 2, pages 44-48, constitute a pattern of laboratory activities which would be suitable for laboratory training in motion and time study. By careful selection and combination of the activities, and by careful scheduling of the available time, these results could be used by a college as a guide in establishing laboratory procedures for single or multiple courses in motion and time study for any number of meetings per week.

Objectives of Laboratory Training

From the tabulation of laboratory activities and the analysis of the purposes of each activity, certain characteristics of motion and time study laboratory training were recognized. As a whole, the laboratory training used methods of educational presentation which were not of the customary nature used in undergraduate instruction. The methods used were an approach, and in some cases actually were, the engineering analysis type of a course. Professor B. R. Teare, Jr., describes the nature of an engineering analysis course as "a course to develop facility in the use of orderly method--the engineering method--in solving engineering problems. It is one in which the primary emphasis is placed on method rather than on subject matter."[4] The objectives of such a course were given as follows:

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[4]B. R. Teare, Jr., "Teaching Methods in Engineering Analysis," The Journal of Engineering Education (American Society for Engineering Education), 35:599, June, 1945.

Thorough understanding of the engineering method and elementary competence in its application. This requires:

(a) comprehension of the interacting elements in situations which are to be analyzed;
(b) ability to think straight in the application of fundamental principles to new problems;
(c) reasonable skill in making approximations, and in choosing the type of approach in the light of the accuracy required and the time available for solution - - in sum, a foundation for engineering judgment;
(d) resourcefulness and originality in devising means to an end;
(e) understanding of the elements of cost in engineering and the ability to deal with this factor just as completely as with technological factors.[5]

Although laboratory instruction in most institutions emphasized a subject matter in a particular laboratory period there were usually combined with this certain analyses and applications characteristic of the engineering analysis course described. This was accomplished by the frequent requirement of an operation analysis, recommendations for improvements, and a cost report in connection with each of the subjects presented whether of a motion study or a time study nature. Some activities did not lend themselves readily to this treatment. The activity of performance rating was one of these, but in subsequent activities the technique was applied in combination with other activities in a manner similar to the engineering analysis type of course. Those institutions that used the methods project, standard data, and time study

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[5] Ibid. p.600, (quoting the 1940 report of A.S.E.E. Aims and Scope Committee).

project activities were using methods of presentation which conformed to the objectives previously quoted.

The laboratory activity tabulation and the analysis of purposes revealed certain characteristics which permitted classification of the general purposes of motion and time study laboratory training. These were for:

(1) inspiration--to inspire or convince the student of the worth and possible accomplishment of motion and time study;

(2) instruction--to inform the student of a particular subject matter, technique, or application;

(3) practice--to develop a certain degree of skill through repetition of performance of the technique; and

(4) application--to develop originality, resourcefulness, judgment, and analytical ability of the student when confronted with an original problem.

These purposes were not accomplished singularly in each of the laboratory activities, but usually a combination of several or all of these objectives were evident in the various activities used in colleges and universities for motion and time study laboratory instruction.

With the recognition of these purposes in motion and time study laboratory training, it should be possible to effectively select the laboratory activities, the method of

presentation, and the facilities and equipment to be used.

Instructional Techniques and Facilities

The analysis of the techniques and facilities used in motion and time study laboratory training revealed several significant characteristics.

One very predominant feature was the reliance in the presentation of the various activities on some type of operation or process which was suitable for the analysis necessary. Such activities as the preparation of process charts, man and machine charts, left and right hand operation charts, motion picture films for micromotion analysis, operation analysis, methods project, time study, motion time data, and standard data required that observations be made of a performed operation to make the instruction effective. This was accomplished in various ways, and when an actual performance was not possible, written descriptions of the process or operations were used with less effect. The predominant method of providing a performance was by simulating an industrial operation by means of an assembly or machine operation performed in the laboratory or by means of machine operations performed in the schools' shops. In using this technique, an attempt was being made to recreate an industrial situation in the laboratory which was suitable for the desired activity. Another method of providing the necessary performance was by means of motion pictures. By this device

motion pictures which had been taken in an industrial plant were used to provide the necessary situation for analysis purpose. In using this technique, an attempt was being made to bring an industrial situation into the laboratory which was suitable for the desired activity. A third method of providing the performance was used by several institutions. This consisted of moving the laboratory to an industrial plant where observation of the situtation was done directly. This was accomplished by the entire class going on plant visits, by assignment of individuals to specific plants, or by leaving it to the initiative of the individual to find a plant suitable for the desired activities.

Another very predominant feature of motion and time study instruction was the importance of motion pictures in this training. Five distinct uses of motion pictures were recognized. These were for:

(1) inspiration--to convince the student of the effectiveness of certain principles and techniques,

(2) instruction--to inform the student of certain principles and techniques,

(3) analysis--to aid an analysis of a particular problem,

(4) simulation--to duplicate industrial operations or processes for the laboratory exercises, and

(5) timing--to determine the time for motions.

It is believed that the last three uses are special for time study training. Motion pictures have been used for micromotion study since it was first developed by Gilbreth. However, it also has been used in connection with process and operation analysis in which non-micromotion or gross breakdowns were made. A fifth use of motion pictures listed is essentially a part of micromotion study. This was the use of motion pictures, or the camera, as a very accurate timing device.

The use of motion pictures as a means of bringing industrial situtations to the laboratory permitted a wider range of activities to be presented. This use was applied for process charts, man and machine charts, left and right hand operation charts, operation analysis, principles of motion economy, time study, and performance rating.

Although motion pictures have been used extensively in motion and time study, it is believed that their use can be more fully utilized with the recognition of these five uses--in combination with each other or when used separately. Especially it is believed that the use of motion pictures for analysis and simulation can be further developed and more extensively utilized for more effective training in motion and time study.

CHAPTER VI

EQUIPMENT AND FACILITIES USED BY COLLEGES

The replies to the questionnaire received from sixty institutions indicated the types of equipment and facilities that were used in motion and time study instruction. A tabulation of this information is shown in Table XII, pages 75 and 76. Some of the equipments included in the tabulation were not used exclusively for motion and time study instruction but were available for regular use in this capacity. This applied especially to cameras, projectors, and various types of tools.

A tabulation reveals the following uses of the various equipments:

1. Stop watches were the most widely used type of equipment. All institutions indicated that this device was used with the decimal minute watch the one used most commonly.

2. Motion picture projectors were used by all but four colleges. The silent motion picture projector was used by 81.7 per cent, the sound projector by 68.2 per cent, and special projectors by 25 per cent of the colleges. Special projectors included those that had been altered or designed specifically for motion and time study work such as for micromotion analysis.

TABLE XII

EQUIPMENT AND FACILITIES USED BY COLLEGES FOR MOTION AND TIME STUDY INSTRUCTION

(Note: Based on information from sixty colleges.)

	No. of Colleges	Per Cent of Total
STOP WATCHES		
Decimal Minute	58	96.7
Decimal Hour	18	30.0
Second	8	13.3
ALL TYPES	60	100.0
(Note: Tabulation includes duplications in that some colleges used more than one type of stop watch.)		
MOTION PICTURE PROJECTORS		
Silent and Sound	21	35.0
Silent, Sound, and Special	13	21.7
Silent	13	21.7
Sound	7	11.7
Silent and Special	2	3.3
ALL TYPES	56	93.4
(Note: A special projector was one that had been altered or designed especially for motion and time study work.)		
Distribution by Each Type:		
Silent	49	81.7
Sound	41	68.2
Special	15	25.0
MOTION PICTURE CAMERAS		
Spring Driven	23	38.3
Spring Driven and Special	13	21.7
Special	8	13.3
ALL TYPES	44	73.3
(Note: A special camera was one that had been altered or designed especially for motion and time study work.)		
Distribution by Each Type:		
Spring Driven	36	60.0
Special	21	35.0

TABLE XII (Continued)

EQUIPMENT AND FACILITIES USED BY COLLEGES FOR MOTION AND TIME STUDY INSTRUCTION

Distribution by Film Size of Camera:		
Sixteen Millimeter	40	90.9
Sixteen Millimeter and Eight Millimeter	3	6.8
Eight Millimeter	1	2.3
(Note: Percentages based on a total of forty-four.)		
STILL CAMERAS		
ALL TYPES	17	28.3
SPECIAL TIMERS		
Microchronometer or Wink Counter	30	50.0
Marstochron	11	18.3
Kymograph	8	13.3
Servis Recorder	3	5.0
Thuesen Automatic Time Recorder	2	3.3
(Note: Tabulation includes devices reported by two or morecolleges.)		
TOOLS		
Hand Tools	51	85.0
Power Hand Tools	33	55.0
Power Wood Working Tools	31	51.7
Power Metal Working Tools	47	78.3

3. Motion picture cameras were not used to the same extent as the projectors, but 73.3 per cent of the colleges reported that cameras were available for use. The sixteen millimeter size of camera was reported in use by all but one school.

4. Still cameras were available for use in only seventeen, or 28.3 per cent, of the institutions. The thirty-five millimeter size of camera was in predominance as ten of the seventeen used this size camera. Eight colleges reported two or more different sizes of cameras.

5. Special timers were not used to any great extent except for the microchronometer, or wink counter, which was used by 50 per cent of the schools. The Marstochron[1] and Servis Recorder (mechanical time recorder)[2], which are instruments suitable for industrial time study work, were reported by eleven and three institutions respectively. The kymograph[3] and Thuesen Automatic Time Recorder[4] were reported by eight and two schools, respectively. Information pertaining to the Servis Recorder and the Thuesen Automatic Time Recorder was

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[1]For description, see L. P. Alford and J. R. Bangs, editors, Production Handbook, (New York: The Ronald Press Co., 1948), p. 465.

[2]Ibid., p. 466.

[3]For description, see Ralph M. Barnes, Motion and Time Study, 3rd ed., (New York: John Wiley and Sons, Inc., 1949), p. 176.

[4]Ibid., p. 178.

volunteered in the replies.

6. Types of tools most commonly used were hand tools and power metal working tools, which were reported by 85.0 and 78.3 per cent of the institutions, respectively. Power hand tools and power wood working tools were each used by more than 50 per cent of the schools. Details as to numbers and variety of each type was not reported in a manner that permitted a detailed tabulation.

7. Numerous types of other equipment and facilities were reported as having been used. Since this information was volunteered in the replies, an accurate tabulation by colleges has not been possible. These other types of equipment and facilities consisted of the following:

a. Strip-film and slide projectors.
b. Opaque projectors.
c. Hand projectors, 16 mm (for film analysis).
d. Editor viewers, 16 mm (for film analysis and editing).
e. Photographic equipment, such as lighting equipment, tripods, light meters, titling equipment, etc.
f. Viewing boxes (for film analysis).
g. Motion pictures.
h. Sound recorders.

i. Calculators.

j. Circuit clocks.

k. Time study training boards (consisting of visual and auditory signals and used for stop watch observation practice).

l. Speed indicators.

m. Counters.

n. Assembly parts and other items, such as playing cards, marbles, economy trays and bins, pin boards, etc.

o. Printed forms.

p. Wall charts.

These results indicate that equipment for motion and time study instruction has consisted primarily of stop watches, motion picture projectors, motion picture cameras, and miscellaneous tools to permit the various activities presented in Chapter V to be carried out. Certain special equipments have been used by some of the colleges, however in most all cases such equipment was either a timing device, a photographic equipment, a visual aid, a processing tool, or a facility to simulate an industrial operation.

CHAPTER VII

INDUSTRIAL TRAINING IN MOTION AND TIME STUDY

An important phase of training in motion and time study has been that done by industrial organizations. The information presented in this chapter pertains to various aspects of the industrial training of motion and time study analysts. This information was obtained from the replies of the questionnaires sent to fifty-seven of the largest companies in the United States. It is not contended that the results give a representation of motion and time study training of all industrial organizations, however it is believed that they are indicative of the more advanced industrial training procedures in motion and time study that has existed in large companies.

Some of the results presented have been relative to three individuals. These were:

Individual "A"--the recent college graduate who had previous training in motion and time study while in college, and who was entering motion and time study work.

Individual "B"--the man who was not a college graduate, but an employee in some other capacity who was entering motion and time study work.

Individual "C"--the man who was not a novice but had been regularly doing motion and time study work.

This classification was used so that differences in the types of training given these individuals could be determined. As previously stated,[1] it has been shown that individuals "A" and "B" have been chosen for motion and time study work in about equal numbers.

EXTENT OF TRAINING

Of the thirty-six companies answering the questionnaire, twenty-eight, or 78 per cent, indicated that classroom or group training was given for individuals doing motion and time study work. Although eight companies stated that classroom or group training was not given, this did not mean that no training was given as replies indicated that on-the-job or apprenticeship methods were used.

Of the twenty-eight companies that gave such training, there was very little difference in the extent of training for the three individuals, "A", "B", and "C", as shown in the following comparison:

Individual "A"----26 companies (93 per cent)

Individual "B"----25 companies (89 per cent)

Individual "C"----24 companies (86 per cent)

This indicated that the training requirements for the three individuals was about the same. The type of training for the college graduate and the non-college graduate was

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[1] Cf. ante, pp. 6 and 8.

stated to be essentially the same in 83 per cent of the companies.

PURPOSES OF INDUSTRIAL TRAINING (TABLE XIII)

There were two major and two minor purposes in the training for individuals doing motion and time study work. The major purposes were (1) to acquaint the individual with the company's general policies and procedures, and (2) to instruct the individual in the techniques and procedures of motion and time study as developed and used by the company. The minor purposes were (1) to instruct the individual in the basic principles of motion and time study, and (2) to give the individual advanced or specialized training.

Considering each of these purposes separately, the replies showed that training in the company's policies and procedures and in the techniques and procedures used by the company were most often given to the recent college graduate, while training in the basic principles of motion and time study was most often given to the non-college graduate, and instruction in advanced or specialized techniques was most often given the man regularly doing motion and time study work. Although 83 per cent of the companies stated that the training for individuals "A" and "B" was essentially the same, considerable difference in purpose existed.

Three additional purposes were volunteered in the questionnaire replies. These were to instruct the individuals (1) in methods of conducting training programs, (2) in the principles of wage incentive administration, (3) in processing procedures.

EMPHASIS OF INDUSTRIAL TRAINING (TABLE XIV)

In the motion and time study training given by the various companies, very rarely was the motion study phase emphasized. Usually motion study and time study received the same emphasis, or time study was emphasized. No great difference existed in the emphasis in the training given individuals "A", "B", and "C".

SUBJECT MATTER OF TRAINING (FIGURE 3)

The one subject matter which received predominant attention in motion and time study training of individuals "A", "B", and "C" was performance rating. Other subject matter which received considerable attention were process analysis, operation analysis, stop watch observation, fatigue allowance determination, personal allowance determination, delay allowance determination, standard data application, and standard data development. Subject matter which received minor attention were micromotion analysis, motion picture photography, standard motion time application, standard motion time development, and work assignments. Additional subjects

TABLE XIII

PRIMARY PURPOSES OF TRAINING IN INDUSTRY
FOR INDIVIDUALS DOING MOTION AND TIME STUDY WORK

Legend

INDIVIDUAL "A"--The recent college graduate entering motion and time study work.

INDIVIDUAL "B"--The non-college man entering motion and time study work.

INDIVIDUAL "C"--The man regularly doing motion and time study work.

- - - - -

PURPOSE	No. of Companies	Per Cent
To Acquaint the Individual with the Company's General Policies and Procedures:		
Individual "A"----------	25	83
Individual "B"----------	24	80
Individual "C"----------	22	73
To Instruct the Individual in the Basic Principles of Motion and Time Study:		
Individual "A"----------	13	43
Individual "B"----------	23	77
Individual "C"----------	10	33
To Instruct the Individual in the Techniques and Procedures of Motion and Time Study as Developed and Used by the Company:		
Individual "A"----------	25	83
Individual "B"----------	23	77
Individual "C"----------	18	60
To Instruct the Individual in Advanced Techniques or Specialized Techniques of Motion and Time Study:		
Individual "A"----------	12	40
Individual "B"----------	10	33
Individual "C"----------	16	53

(Note: Results were based on replies of twenty-eight companies. Training given by a company was not limited to only one purpose.)

volunteered by the respondents were conducting conferences and training programs, labor agreements, job classification, and plant layout. Differences in emphasis of subject matter for individuals "A", "B", and "C" were of a minor nature.

Additional information shown in Figure 3 is a tabulation of replies pertaining to the subjects which the respondents indicated should receive additional emphasis at the college level. The five subjects that were indicated by the greatest number of persons expressing an opinion were process analysis, operation analysis, performance rating, fatigue allowance determination, and standard data development. On a percentage basis, it was indicated that motion picture photography, standard data development, and standard motion time development be given a greater emphasis in college training than was given by the companies in their own training. Considerably less emphasis was shown for stop watch reading, personal allowance determination, and delay allowance determination in college training as compared to company training.

USE OF MOTION PICTURES (TABLE XV)

Of the companies replying to the questionnaire, answers relating to the use of motion picture photography were given by thirty companies. These answers showed that twenty-five, or 83 per cent, used motion pictures. The predominant use of motion pictures was for training in performance rating.

TABLE XIV

EMPHASIS OF INDUSTRIAL TRAINING
IN MOTION STUDY AND TIME STUDY

Legend

INDIVIDUAL "A"--The recent college graduate entering motion and time study work.

INDIVIDUAL "B"--The non-college man entering motion and time study work.

INDIVIDUAL "C"--The man regularly doing motion and time study work.

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	No. of Companies	Per Cent
Motion Study Emphasized:		
Individual "A"	1	3
Individual "B"	2	7
Individual "C"	1	3
Time Study Emphasized:		
Individual "A"	15	50
Individual "B"	12	40
Individual "C"	12	40
Same Emphasis for Motion Study and Time Study:		
Individual "A"	12	40
Individual "B"	12	40
Individual "C"	14	47

(Note: Results were based on replies received from thirty companies. Some companies did not give a reply for each of the types of individuals, however the percentage figure is based on thirty representing 100 per cent.)

Legend

A ☐ Training given the recent college graduate entering motion and time study work, as based on replies from twenty-nine companies.

B ☐ Training given the non-college man entering motion and time study work, as based on replies from twenty-eight companies.

C ☐ Training given the man regularly doing motion and time study work, as based on replies from twenty-eight companies.

D ☐ Training that should receive additional emphasis at the college level, as based on replies from nineteen companies.

(Note: First figure in parentheses indicates percentage of companies replying; second figure indicates the number of companies replying.)

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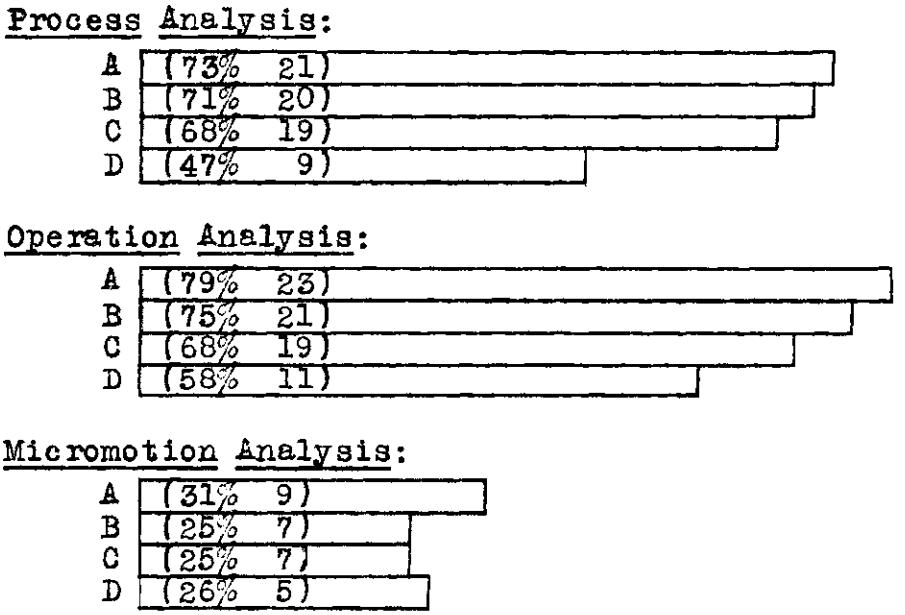

FIGURE 3

COMPARISON OF SUBJECTS INCLUDED IN MOTION AND TIME STUDY TRAINING AS GIVEN IN INDUSTRY

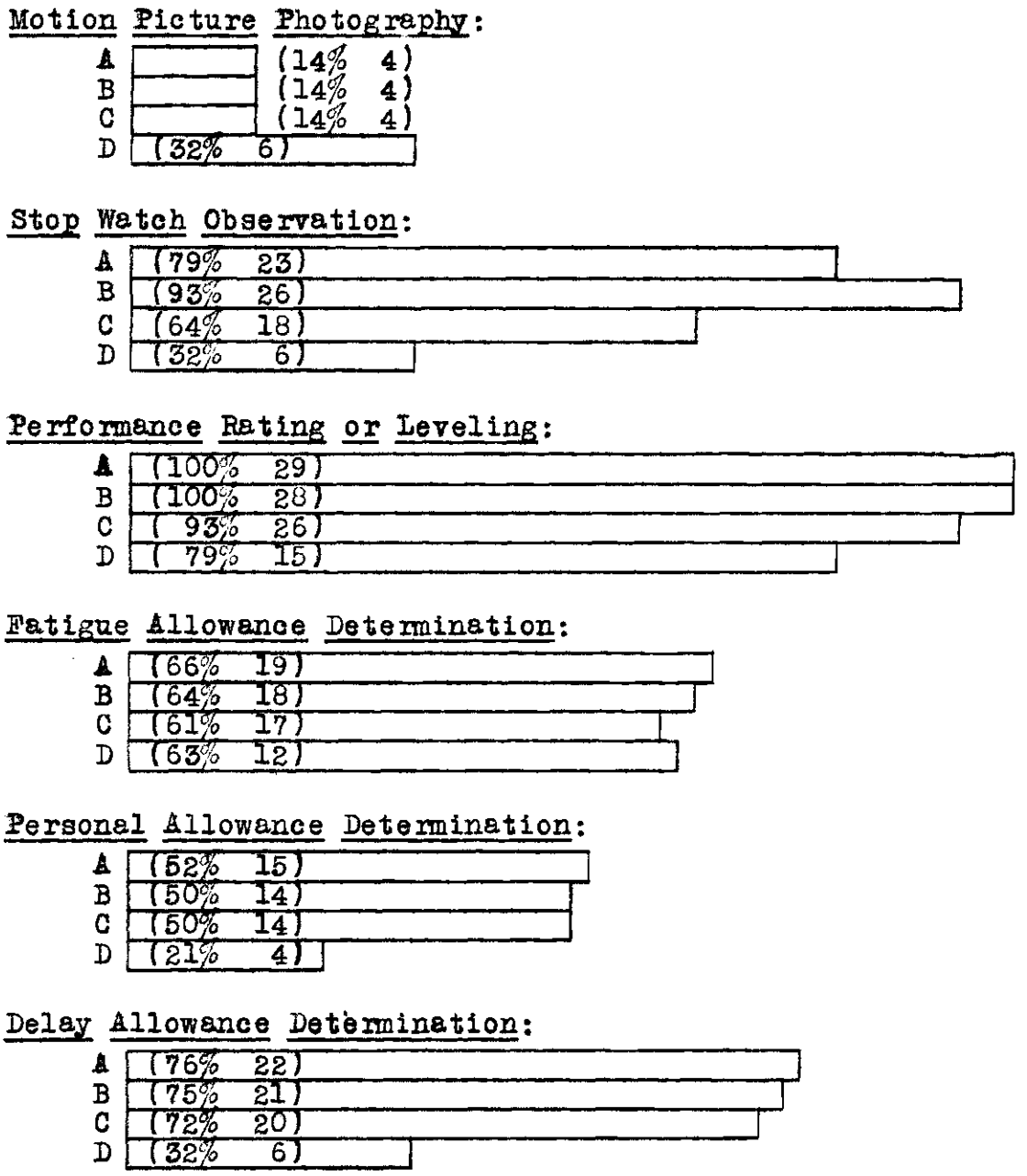

FIGURE 3 (Continued)

COMPARISON OF SUBJECTS INCLUDED
IN MOTION AND TIME STUDY TRAINING
AS GIVEN IN INDUSTRY

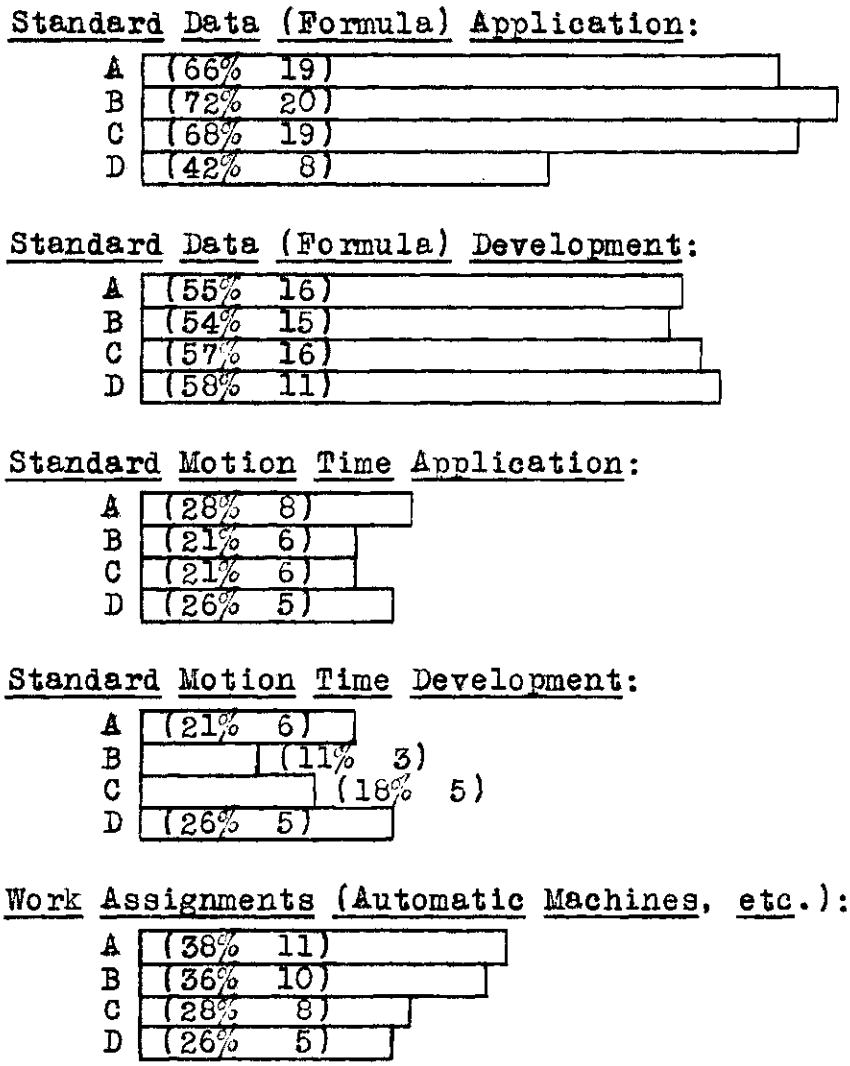

FIGURE 3 (Continued)

COMPARISON OF SUBJECTS INCLUDED
IN MOTION AND TIME STUDY TRAINING
AS GIVEN IN INDUSTRY

Eighty-eight per cent of the companies using motion pictures used them in this activity. Less than half this number, or 40 per cent, used pictures for process analysis, and from 20 to 28 per cent used them for micromotion study, operator training, and standard procedures. Four companies volunteered the information that pictures were used for motion and time study training other than performance rating.

USE OF TIMING DEVICES (TABLE XV)

Of thirty-two companies that gave information about the types of timing devices used, all of the companies stated that stop watches were used in connection with motion and time study work. No other timing device was used to any significant extent. The electric, paper tape, time study machine (Marstochron) was used by three companies and the kymograph by one company. Two companies volunteered the information that the Thuesen Automatic Time Recorder was used, and two companies stated that motion picture cameras operated at 1000 frames per minute were used as a timing device. All of the timing devices except the stop watch were used only infrequently, whereas the stop watch was used regularly by all companies.

SUMMARY OF CONCLUSIONS

Partial conclusions pertaining to motion and time

TABLE XV

INDUSTRIAL USES OF MOTION PICTURES AND TIMING DEVICES IN MOTION AND TIME STUDY WORK

	No. of Companies	Per Cent
Extent of Use of Motion Pictures as Reported by Thirty Companies:		
Motion Pictures Used	25	83
Motion Pictures Not Used	5	17
Nature of Use of Motion Pictures as Reported by Twenty-five Companies:		
Micromotion Study	5	20
Process Analysis	10	40
Operator Training	7	28
Standard Procedures	7	28
Training in Performance Rating	22	88
Motion and Time Study Training	4	(Volunteered)
Extent of Use of Timing Devices as Reported by Thirty-two Companies:		
Stop Watch	32	100
Marstochron	3	10
Kymograph	1	3
Thuesen Automatic Time Recorder	2	(Volunteered)
Motion Picture Camera (at 1000 frames per minute)	2	(Volunteered)

study training in industry based on the results presented are summarized as follows:

1. Formal or classroom instruction in motion and time study has been commonly given by the larger industrial companies in the United States, however it usually has been given in connection with on-the-job training.

2. There is no significant distinction among the types of training given the recent college graduate, the non-college graduate, or the experienced time study man, however there are recognizable differences in the purposes of such training.

3. The most predominant purpose of motion and time study training has been to acquaint the individual with the company's general policies and the specific procedures of motion and time study used by it. This training has been given the experienced analyst as well as the beginner.

4. Significantly more emphasis has been placed on time study techniques than on motion study techniques.

5. Predominant attention in subject matter has been directed toward process analysis, operation analysis, stop watch observation, performance rating, fatigue allowance determination, personal allowance determination, delay allowance determination, standard data application, and standard data development.

6. Industrial opinion is that instruction in process analysis, operation analysis, performance rating, fatigue

allowance determination, and standard data development should receive considerably more emphasis at the college level of instruction than these subjects have been receiving.

7. Motion pictures are predominantly used in connection with motion and time study training and process analysis.

8. Timing devices other than stop watches are used very infrequently.

CHAPTER VIII

CONCLUSIONS

Specific conclusions pertaining to individual chapters have been previously presented. It is the purpose of this final chapter to state the general conclusions and to discuss the more significant conclusions reached.

INSTITUTIONAL AND INDUSTRIAL TRAINING COMPARED

The results obtained from the industrial survey can be used, with certain limitations, as a basis for determining the effectiveness of institutional instruction in motion and time study.

Emphasis in Training

A difference existed in the relative emphasis placed on motion study and time study in institutional and industrial training. In institutional training the emphasis was stated to be about the same between motion study and time study.[1] In industrial training the emphasis was on time study rather than motion study.[2]

In offering an explanation for this difference, the nature of the two subjects must be considered. Neither of the subjects of motion study nor time study has been reduced to a set of established principles because each has been a

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[1] Cf. ante. p. 67
[2] Cf. ante. p. 83

subject dependant on industrial practices.

Motion study, as a subject, has been essentially the study of analysis techniques which were used most generally in in the analysis of work accomplishment, and time study, as a subject, has been the study of the techniques used in measuring work accomplishment. The two subjects are overlapping in nature and a complete study cannot be made of either without the study of the other. The same holds true for the industrial application of motion study and time study, and this has been the reason why the two are considered, broadly speaking, one subject.

When considered separately, the procedures used in motion study have been more standardized, and certain phases of motion study have been reduced to what might be thought of as basic principles of analysis. Also, motion study has been a technique of general application.

The procedures used in time study have not been generally standardized, and considerable differences have existed in the techniques of application. Also, time study has had limited application, and when applied, the procedures must be very specific.

Since motion study procedures were more standardized, it lent itself more easily to academic presentation, and since it had more general application, it has been more acceptable. However, time study, consisting of many varying

procedures, with limited application, has been considered the least important of the two subjects from a pedagodical standpoint.

From an industrial standpoint, this situation was reversed. Industrially, the two subjects assumed relative importance dependant on the purpose of their uses. Briefly stated, the purpose of motion study is to bring about the greatest human or mechanical effectivenss in labor accomplishment, and the purpose of time study is to establish the time it should take a normal or average operator working under standardized conditions to accomplish a specified amount of work. Usually, such a time standard is used in connection with a wage incentive plan. The individual responsible for establishing the standard is usually concerned with the administration of the wage incentive. Thus, in industrial applications time study was closely associated with wage incentives, which has not been the case in academic consideration of the subject.

For any particular company the time study procedures have been established as a matter of company policy. This has not been true with motion study. It is for this reason that differences in time study procedures must be eliminated within any one particular company. This was reflected in the results showing the primary purposes of training for individuals doing motion and time study work. These results did

not show that the primary purposes were to instruct in basic and advanced techniques of motion and time study, but the primary purposes were to acquaint the individual with company policy and the company's developed techniques of application.

For these reasons it is believed that a difference in emphasis between institutional and industrial training existed and perhaps justifiably so.

Emphasis on Subject Matter. A comparison of emphasis on subject matters between institutional and industrial training shows that the activities of process analysis, operation analysis, stop watch observation, performance rating, and standard data were emphasized, and to approximately the same degree, in both types of training. Although identical subject matters were not shown for institutional and industrial training, sufficient similarities existed to permit such a general comparison. Replies to the industrial questionnaire pertaining to subjects which should receive additional emphasis at the college level showed that the subjects of process analysis, operation analysis, performance rating, and standard data development were frequently indicated as subjects that should receive additional emphasis. Since institutional training has emphasized these subjects, it is felt that additional emphasis has not been warranted unless additional total time should be devoted to motion and time study training.

The technique of micromotion study was emphasized considerably more in institutional training than in industrial training. Results also indicated that micromotion study was a technique of analysis infrequently used in industry. These results may indicate that micromotion study has been overemphasized in institutional training, and that the time devoted to this activity could be more effectively used on other subjects. Whether micromotion study has not been as effective in industry as other methods of analysis, or whether its effectiveness has not yet been realized cannot be answered by the results of this investigation. In this connection, it was significant that industrial opinion indicated that more emphasis should be placed on institutional training in motion picture photography than industry was giving to it.

Although motion picture photography has had numerous uses in connection with motion and time study, its closest association has usually been with micromotion study. Results have indicated, however, that motion pictures were used more frequently for training in motion and time study and for process analysis than for micromotion study. If a need has existed for more individuals trained in the techniques of motion picture photography, results indicated that it would be used more for training and process analysis than for micromotion study.

Considerable differences have existed in the emphasis on fatigue, personal, and delay allowance determination between institutional and industrial training. It is doubtful that a satisfactory comparison can be made of these topics because of the possibility that in institutional training the topics were covered in the theory portion of the instruction, and that laboratory time was devoted to other activities. It was significant, however, that very few institutions had laboratory activities pertaining to the allowances, and since fatigue has usually been given prominent consideration in both motion study and time study, it was especially significant that no laboratory time by any institution was devoted to this topic. Industrial opinion indicated that additional emphasis should be given fatigue allowance determination in training at the college level.

Although differences existed between institutional and industrial training, it is believed that the results have shown a fair degree of conformance in the coverage of subject matter by the two types of training.

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APPENDIXES

TABLE XVI

COLLEGES AND UNIVERSITIES THAT GAVE MOTION AND TIME STUDY INSTRUCTION IN 1948

Columnar Explanations and Notes

COLUMN 1: Code number of college or university.

COLUMN 2: Name of college or university that gave motion and time study instruction in 1948. (It does not include any institution that had given instruction in motion and time study and had discontinued such instruction prior to 1948. Instruction had been given but discontinued by the University of Santa Clara, the University of Washington, and West Virginia University.

An asterick indicates that a questionnaire reply was received from the institution.

COLUMN 3: Location of the institution by name of state.

COLUMN 4: Total institutional undergraduate enrollment for school year 1946-1947. Source: A. J. Brumbaugh, ed., American Universities and Colleges, 5th edition, Washington, D. C.: American Council on Education, 1948.

COLUMN 5: Undergraduate enrollment in technological courses for school year 1946-1947. Source: A. J. Brumbaugh, ed., American Universities and Colleges, 5th edition, Washington, D. C.: American Council on Education, 1948.

COLUMN 6: Designation of "x" indicates institutional affiliation with the American Society for Engineering Education as of 1947. Source: The Journal of Engineering Education, American Society for Engineering Education, 38:1-6, Feb., 1948.

COLUMN 7: Designation of "x" indicates the accreditation of an industrial engineering (or similar) curriculum by the Engineers' Council for Professional Development as of 1946. Source: Fourteenth Annual Report, Engineers' Council for Professional Development, Sept. 30, 1946, p. 24.

COLUMN 8: School year in which the institutional catalogue used as a source of data was published.

COLUMN 9: Curriculum which required motion and time study as a subject. Source: Institutional catalogue.

COLUMN 10: Department in which motion and time study instruction was performed. Source: Institutional catalogue or questionnaire reply.

COLUMN 11: College or university division, such as engineering, commerce, etc., of which the department of Column 10 was a part. Source: Institutional catalogue.

Abbreviations used in Columns 9, 10, and 11:

Adm.----------Administration
Adm. E.---------Administrative Engineering
Busi.----------Business
B. A.----------Business Administration
B. & E.---------Business and Engineering
B. M.----------Business Management
Comm.----------Commerce
Engg.----------Engineering
E. & B.---------Engineering and Business
Fact.----------Factory
G. E.----------General Engineering
Ind.----------Industrial
I. A.----------Industrial Administration
I. E.----------Industrial Engineering
I. M.----------Industrial Management
Mgt.----------Management
Mgt. E.---------Management Engineering
Mfg.----------Manufacturing
M. E.----------Mechanical Engineering
Prod.----------Production

COLUMN 12: Number of required course subjects in motion and time study that would have to be taken by an undergraduate student in fulfillment of the requirements for a degree. Source: Institutional catalogue.

COLUMN 13: Designation of "c" indicates that motion study and time study were presented as a combined subject; designation of "s" indicates that motion study and time study were presented as separate course subjects. Source: Institutional catalogue.

COLUMN 14: Class year in curriculum that motion and time study subject or subjects were scheduled. Source: Institutional catalogue.

COLUMN 15: Year in which motion and time study instruction was first given. Source: Questionnaire reply.

COLUMN 16: Year in which motion and time study laboratory instruction was first given. Source: Questionnaire reply.

Question mark following year indicates that the year given was the earliest date known by the individual answering the questionnaire; dash (--) indicates that year was not given in reply.

COLUMN 17: Approximate number of students given motion and time study instruction in one school year as of 1948. Source: Questionnaire reply.

COLUMN 18: Years in which special or short industrial courses in motion and time study were given. Source: Questionnaire reply. (Note: Some replies indicated that such courses were given during the war years without giving specific years. These have been shown as the years 1941-1945.)

COLUMN 19: Designation of text or texts used. Source: Questionnaire reply.

Abbreviations:

Barnes	Barnes, Motion and Time Study
Barnes(2)	Barnes, Work Methods Training Manual
Barnes(4)	Barnes, Motion and Time Study Applications
Holmes	Holmes, Applied Time and Motion Study
L-M-S	Lowry, Maynard, and Stegemerten, Time and Motion Study
Maynard-Stegemerten	Maynard and Stegemerten, Operation Analysis
Maynard	Maynard, Stegemerten, and Schwab, Methods Time Measurement

Morrow----------Morrow, Time Study and Motion Economy

Mundel----------Mundel, Systematic Motion and Time Study

Production Hand Book---Alford and Bangs, Production Hand Book

Sampter----------Sampter, Motion Study

Schutt----------Schutt, Time Study Engineering

Shumard----------Shumard, Primer of Time Study

COLUMN 20: Designation of laboratory manual or manuals used. Source: Questionnaire reply.

Abbreviations:

Barnes(u)----------Barnes, undesignated
Barnes(3)----------Barnes, Work Measurement Manual
Barnes(4)----------Barnes, Motion and Time Study Applications

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TABLE XVI

COLLEGES AND UNIVERSITIES THAT GAVE
MOTION AND TIME STUDY INSTRUCTION IN 1948

(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Akron, Univ. of	Ohio	4,838	565	x	x
2.	Alabama, Polytechnic Inst.	Ala.	6,140	1,931	x	
3.	Alabama, Univ. of*	Ala.	8,408	1,598	x	x
4.	Arkansas, Univ. of*	Ark.	4,986	1,029	x	
5.	Boston University*	Mass.	11,005			
6.	Bradley University	Ill.	4,991	699	x	
7.	Buffalo, Univ. of*	N. Y.	9,442	882	x	
8.	Calif., Univ. of (Berkeley)*	Calif.	21,909	3,429	x	x
9.	Calif., Univ. of (L. A.)*	Calif.	13,799	1,264	x	
10.	Calif., Univ. of So.*	Calif.	11,999	1,998	x	
11.	Carnegie Inst. of Tech.	Pa.	3,304	2,287	x	x
12.	Case Inst. of Tech.	Ohio	1,287	1,287	x	
13.	Cincinnati, Univ. of*	Ohio	15,474	2,082	x	
14.	Clarkson College of Tech.*	N. Y.	1,340	1,340	x	x
15.	Colorado, Univ. of	Colo.	7,641	3,149	x	

*Answered questionnaire

TABLE XVI (Continued)

COLLEGES AND UNIVERSITIES THAT GAVE
MOTION AND TIME STUDY INSTRUCTION IN 1948

(1)	(2)	(3)	(4)	(5)	(6)	(7)
16.	Columbia University*	N. Y.	4,624	944	x	x
17.	Connecticut, Univ. of*	Conn.	7,174	1,418	x	
18.	Cornell University	N. Y.	7,984	2,444	x	x
19.	Dartmouth College*	N. H.	2,673	109	x	
20.	Delaware, Univ. of*	Dela.	1,817	624	x	
21.	Denver, Univ. of*	Colo.	7,911	701	x	
22.	Drexel Inst. of Tech.	Pa.	2,043	2,043	x	
23.	Evansville College*	Ind.	1,502			
24.	Fenn College	Ohio	4,739	1,445	x	
25.	Florida, Univ. of	Fla.	6,079	1,524	x	x
26.	Georgia Inst. of Tech.*	Ga.	4,423	4,423	x	x
27.	Illinois Inst. of Tech.*	Ill.	7,377	7,100	x	
28.	Illinois, Univ. of*	Ill.	20,427	4,428	x	
29.	Indiana University*	Ind.	10,350			
30.	Iowa State College*	Iowa	9,610	4,557	x	
31.	Iowa, State Univ. of*	Iowa	8,439	637	x	x
32.	Johns Hopkins University*	Md.	4,837	738	x	

TABLE XVI (Continued)

COLLEGES AND UNIVERSITIES THAT GAVE
MOTION AND TIME STUDY INSTRUCTION IN 1948

(1)	(2)	(3)	(4)	(5)	(6)	(7)
33.	Kansas State College	Kans.	6,267	2,358	x	x
34.	Kansas, Univ. of*	Kans.	8,513	2,218	x	x
35.	Kent State University*	Ohio	4,729			
36.	Lafayette College*	Pa.	1,440	1,440	x	x
37.	Lehigh University	Pa.	2,928	1,801	x	x
38.	Louisiana State University*	La.	10,028	1,105	x	
39.	Massachusetts Inst. of Tech.*	Mass.	3,811	3,811	x	x
40.	Miami, Univ. of*	Fla.	6,887			
41.	Michigan College of Mining	Mich.	1,829	1,829	x	
42.	Michigan State College*	Mich.	12,261	2,424	x	
43.	Michigan, Univ. of*	Mich.	15,842	4,170	x	
44.	Minnesota, Univ. of*	Minn.	24,479	5,313	x	
45.	Mississippi State College*	Miss.	2,952	844	x	
46.	Montana State College	Mont.	3,053	1,306	x	
47.	Newark College of Engg.*	N. J.	2,306	2,306	x	
48.	New York University	N. Y.	27,227	3,161	x	x
49.	North Carolina State Col.*	N. C.	4,728	3,014	x	

TABLE XVI (Continued)

COLLEGES AND UNIVERSITIES THAT GAVE
MOTION AND TIME STUDY INSTRUCTION IN 1948

(1)	(2)	(3)	(4)	(5)	(6)	(7)
50.	North Carolina, Univ. of*	N. C.	6,065			
51.	Northeastern University*	Mass.	6,610	1,580	x	x
52.	Northwestern University*	Ill.	20,688	1,071	x	
53.	Notre Dame, Univ. of	Ind.	4,312	1,073	x	
54.	Ohio State University*	Ohio	22,740	4,382	x	x
55.	Oklahoma A. & M. College*	Okla.	10,102	3,172	x	x
56.	Oklahoma, Univ. of*	Okla.	10,679	3,263	x	
57.	Oregon State College*	Ore.	7,519	1,823	x	
58.	Pennsylvania State College*	Pa.	9,670	1,359	x	x
59.	Pittsburgh, Univ. of*	Pa.	12,132	2,086	x	x
60.	Purdue University*	Ind.	10,524	5,576	x	x
61.	Rennsellaer Polytech. Inst.*	N. Y.	3,214	3,214	x	x
62.	Rhode Island State College*	R. I.	2,156	661	x	
63.	Rochester, Univ. of	N. Y.			x	
64.	Seton Hall College*	N. J.	8,131			
65.	Sinclair College*	Ohio			X	
66.	Stanford University*	Calif.	4,799	595	x	

TABLE XVI (Continued)

COLLEGES AND UNIVERSITIES THAT GAVE
MOTION AND TIME STUDY INSTRUCTION IN 1948

(1)	(2)	(3)	(4)	(5)	(6)	(7)
67.	Syracuse University*	N. Y.	13,978	1,324	x	x
68.	Tennessee Polytech. Inst.*	Tenn.	1,416	1,017		
69.	Tennessee, Univ. of*	Tenn.	7,793	1,779	x	
70.	Texas A. & M. College	Texas	8,624	4,201	x	
71.	Texas Techn. College*	Texas	5,996	2,003	x	
72.	Texas, Univ. of*	Texas	15,951	3,847	x	
73.	Toledo, Univ. of*	Ohio	4,264	919	x	
74.	Utah, Univ. of*	Utah	8,463	1,158	x	
75.	Vermont, Univ. of*	Vt.	1,833	579	x	
76.	Virginia Polytech. Inst.*	Va.	4,431	3,041	x	x
77.	Washington University	Mo.	6,699	1,078	x	x
78.	Wayne University*	Mich.	13,081	1,262	x	
79.	Wisconsin, Univ. of*	Wisc.	16,047	3,427	x	
80.	Youngstown College	Ohio	3,217			

TABLE XVI (Continued)
(Sheet 2)

COLLEGES AND UNIVERSITIES THAT GAVE
MOTION AND TIME STUDY INSTRUCTION IN 1948

(1)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1.	1947-48	M. E. Option	I. M.	Comm.	2	s	Jr. Jr.
2.	1946-47	I. M.	I. M.	Engg.	1	c	Jr.
3.	1946-47	I. E.	I. E.	Engg.	2(1)	c	Jr. Sr. Elect.
4.	1947-48	None	Mgt.	B. A.	(1)	c	Elect.
5.	1946-47	Prod. Mgt.	B. A.	B. A.	2	s	
6.	1947-48	M. E. Option	I. E.	Engg.	1	c	Sr.
7.	1947-48	I. E.	I. E.	Engg.	2	s	
8.	1947-48	M. E. Option	M. E.	Engg.	1	c	
9.	1947-48	I. M.	B. A.	B. A.	1	c	
10.	1947-48	I. E.	Mgt.	Comm.	1	c	
11.	1946-47	Mgt. E.	Mgt. E.	Engg.	1	c	Sr.
12.	1947-48	Adm. E.	M. E.	Engg.	1		
13.	1947-48	I. M.	M. E.	Engg.	2	c	
14.	1945-46	I. E.	B. A.	B. A.	1(1)	c	Sr. Elect.
15.	1947-48	M. E. & Busi.	Mgt.	Busi.	1	c	

TABLE XVI (Continued)
(Sheet 2)

COLLEGES AND UNIVERSITIES THAT GAVE
MOTION AND TIME STUDY INSTRUCTION IN 1948

(1)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
16.	1947-48	I. E.	I. E.	Engg.	1	c	Sr.
17.	1947-48	I. A.	Ind.	B. A.	1(1)	c	Jr. Elect.
18.	1947-48	M. E. Option	I. E.	Engg.	1	c	
19.	1947-48	Engg. & B. A.	I. E.	Engg.	1	c	
20.	1947-48	M. E.	M. E.	Engg.	1	c	Jr.
21.	1944-45	Comm. Engg.	M. E.	Engg.	1	c	Jr.
22.	1947-48	M. E. Option	M. E.	Engg.	1	c	Sr.
23.	1947-48	Mgt.	Mgt.	Busi.	1	c	
24.	1947-48	M. E. Option	M. E.	Engg.	1	c	Sr.
25.	1946-47	I. E.	I. E.	Engg.	1	c	Sr.
26.	1947-48	I. E.	I. E.	Engg.	1	c	Jr.
27.	1945-46	I. E.	I. E.	Engg.	1(1)	c	Jr. Elect.
28.	1947-48	M. E. Option	M. E.	Engg.	1	c	
29.	1946-47	None	Busi.	Busi.	(1)	c	Elect.
30.	1947-48	G. E. Option	G. E.	Engg.	2	c	Soph. Sr.
31.	1946-47	M. E. Option	M. E.	Engg.	1(1)	c	Jr. Elect.
32.	1947-48	I. E.	I. E.	Engg.	2	c	Sr. Sr.

TABLE XVI (Continued)
(Sheet 2)

COLLEGES AND UNIVERSITIES THAT GAVE
MOTION AND TIME STUDY INSTRUCTION IN 1948

(1)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
33.	1947-48	M. E. Option	Shop	Engg.	1	c	Jr.
34.	1946-47	M. E. Option	M. E.	Engg.	1	c	
35.	1943-44	Fact. Mgt.	B. A.	B. A.	1	c	Sr.
36.	1944-45	M. E. Option	M. E.	Engg.	1	c	Jr.
37.	1947-48	I. E.	I. E.	Engg.	1	c	Sr.
38.	1946-47	M. E. Option	I. E.	Engg.	1	c	Jr.
39.	1944-45	B. & E. Adm.	B. & E. Adm.	Engg.	(2)	c	Elect.
40.	1947-48	I. M.	B. A.	B. A.	(1)	c	Elect.
41.	1946-47	None	M. E.	Engg.	(1)	c	Elect.
42.	1947-48	None	M. E.	Engg.	(1)	c	Elect.
43.	1945-46	M. E. Option	M. E.	Engg.	1	c	
44.	1945-46	E. & B. Adm.	M. E.	Engg.	(2)	c	Elect.
45.	1947-48	M. E. Option	M. E.	Engg.	1	c	Sr.
46.	1947-48	I. E.	I. E.	Engg.	1	c	Sr.
47.	1946-47	I. E.	I. E.	Engg.	1	c	
48.	1947-48	Adm. E.	Adm. E.	Engg.	2	c	Sr. Sr.
49.	1947-48	I. E.	I. E.	Engg.	1	c	Jr.

TABLE XVI (Continued)
(Sheet 2)

COLLEGES AND UNIVERSITIES THAT GAVE
MOTION AND TIME STUDY INSTRUCTION IN 1948

(1)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
50.	1947-48	Prod. Mgt.	Comm.	Comm.	1	c	
51.	1947-48	I. E. (5 yr.)	I. E.	Engg.	2	c	Sr. 5th
52.	1947-48	I. E. (5 yr.)	Mgt.	Comm.	2	c	Jr.
53.	1944-45	None	M. E.	Engg.	(1)	c	Elect.
54.	1947-48	I. E. (5 yr.)	I. E.	Engg.	1	c	Sr.
55.	1947-48	I. E.	I. E.	Engg.	1	c	Jr.
56.	1947-48	None	Busi. Mfg.	B. A.	(1)	c	Elect.
57.	1947-48	I. E.	I. E.	Engg.	2	s	Jr. Jr.
58.	1947-48	I. E.	I. E.	Engg.	2	s	Jr. Jr.
59.	1947-48	I. E.	I. E.	Engg.	3	c	Jr. Jr. Sr.
60.	1947-48	M. E. Option	G. E.	Engg.	1(1)	c	Jr. Elect.
61.	1947-48	Mgt. E.	Mgt. E.	Engg.	1	c	Jr.
62.	1946-47	I. M.	M. E.	Engg.	1	c	Soph.
63.	1947-48	M. E.	I. E.	Engg.	1	c	
64.	1946-47	B. M.	B. M.	B. M.	1	c	Sr.
65.	1947-48	M. E.	B. M.	B. M.	1	c	
66.	1947-48	I. E.	M. E.	Engg.	1	c	

TABLE XVI (Continued)
(Sheet 2)

COLLEGES AND UNIVERSITIES THAT GAVE
MOTION AND TIME STUDY INSTRUCTION IN 1948

(1)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
67.	1946-47	Adm. E.	Adm. E.	Engg.	1	c	Jr.
68.	1947-48	M. E.	G. E.	Engg.	1	c	Sr.
69.	1947-48	I. E.	I. E.	Engg.	1	c	Jr.
70.	1946-47	Mgt. E.	Mgt. E.	Engg.	1	c	Sr.
71.	1944-45	I. E.	I. E.	Engg.	1	c	Jr.
72.	1947-48	None	M. E.	Engg.	(1)	c	Elect.
73.	1943-44	None	Mgt.	B. A.	(1)	c	Elect.
74.	1947-48	M. E. Option	M. E.	Engg.	1	c	Sr.
75.	1946-47	I. M.	M. E.	Engg.	1	c	Sr.
76.	1947-48	I. E.	I. E.	Engg.	1	c	Sr.
77.	1947-48	I. E.	I. E.	Engg.	1	c	Sr.
78.	1946-47	I. E.	M. E.	Engg.	1	c	Jr.
79.	1946-47	None	M. E.	Engg.	(1)	c	Elect.
80.	1946-47	I. E.	Engg.	Engg.	2	c	Jr. Jr.

TABLE XVI (Continued)
(Sheet 3)

COLLEGES AND UNIVERSITIES THAT GAVE
MOTION AND TIME STUDY INSTRUCTION IN 1948

(1)	(15)	(16)	(17)	(18)	(19)	(20)
1.						
2.						
3.	1936	1936	100	1936-1948	Mundel	Smalley (Dept.)
4.	1948	1948	90	None	Morrow	
5.	1925	None	117	-1948	Morrow	
6.						
7.	1946	1946	30	None	Not Given	
8.	1943	1943	250	1941-1945	Barnes	Davis (Dept.)
9.	1941	1949*	50	None	Instructor's Notes	Barnes(u)
10.	1940?	1941	275	1941-1945	Mundel	
11.						
12.						
13.	1941	None	100	None	Not Given	
14.	1942	1943	45	1942-1946	Barnes	Univ. of Mich.
15.						

*Proposed

TABLE XVI (Continued)
(Sheet 3)

COLLEGES AND UNIVERSITIES THAT GAVE
MOTION AND TIME STUDY INSTRUCTION IN 1948

(1)	(15)	(16)	(17)	(18)	(19)	(20)
16.	1946	1946	160	None	Morrow	
17.	1938	None	95	1941-1945	Schutt, Maynard-Stegemerten	
18.						
19.	1947	1947	6	None	Barnes	
20.	1939	1939	18	None	Barnes	Departmental
21.	1948	1948	40	None	Barnes	Barnes(u)
22.						
23.	1946	1946	60	None	Barnes	
24.						
25.						
26.	1926	1926	400	1946-1948	Morrow	
27.	1940?	1941?	175	1941-1945	L-M-S	
28.	--	--	85	1941-1945	Barnes	
29.	1946	1948	75	None	Barnes, L-M-S	Departmental
30.	1925?	1925?	410	None	Barnes, L-M-S	
31.	1928	1928	150	1937-1948	Barnes, Barnes(2)	Barnes(3) Barnes(4)
32.	1946	1946	35	1941-1945	L-M-S, Shumard	

TABLE XVI (Continued)
(Sheet 3)

COLLEGES AND UNIVERSITIES THAT GAVE
MOTION AND TIME STUDY INSTRUCTION IN 1948

(1)	(15)	(16)	(17)	(18)	(19)	(20)
33.						
34.	--	--	110	None	L-M-S	
35.	1937	1937	15	None	Barnes	Murray Corp., Thompson Products
36.	1925	1925	100	1941-45	Production Hand Book	Departmental
37.						
38.	1946	1947	12	None	Barnes, L-M-S, Maynard-Stegemerten	
39.	1933	1933	160	None	Barnes, Sampter	Departmental
40.	1948	1948	60	None	Barnes, Barnes(2)	Barnes(4)
41.						
42.	1905?	--	115	1941-45	L-M-S	
43.	1935	--	200	1946	Barnes	Departmental
44.	1929	1929	150	-1948	Barnes, Maynard, Mundel	Barnes(3)
45.	1939	1939	33	None	Barnes	
46.						
47.	1940	1940	100	1941-45	Barnes	Departmental
48.						
49.	1940	1940	70	None	Morrow	

TABLE XVI (Continued)
(Sheet 3)

COLLEGES AND UNIVERSITIES THAT GAVE
MOTION AND TIME STUDY INSTRUCTION IN 1948

(1)	(15)	(16)	(17)	(18)	(19)	(20)
50.	1931	1931	30	1942-48	L-M-S	Departmental
51.	1936	1936	90	1941-45	Barnes	
52.	1933?	1938?	275	None	Barnes, Barnes(4) L-M-S, Notes	Departmental
53.						
54.	1925	1926	300	1941-45	Not Given	
55.	1925	1925	175	1946-47	Barnes	
56.	1945	1945	95	1946-48	Barnes, L-M-S	Barnes(4)
57.	1937	1939	260	1942-43	Barnes, Holmes	Departmental
58.	1908	1931	210	1916-48 (Intermittent)	L-M-S, Maynard-Stegemerten	
59.	1926?	1934	100	1943	L-M-S	
60.	--	--	630	1941-48	Mundel	Mundel (Dept.)
61.	1945	1946	140	None	Morrow	Departmental
62.	1943	1947	50	1942-48	Barnes	
63.						
64.	1946	None	200	None	L-M-S	
65.	1941?	None	20	None	L-M-S	
66.	1941	1941	60	1941-43	L-M-S	

TABLE XVI (Continued)
(Sheet 3)

COLLEGES AND UNIVERSITIES THAT GAVE
MOTION AND TIME STUDY INSTRUCTION IN 1948

(1)	(15)	(16)	(17)	(18)	(19)	(20)
67.	1942	1942	100	-1948	Barnes	
68.	1944	1945	80	None	L-M-S	
69.	1935	1948	80	1948	Barnes	Departmental
70.						
71.	1935	1935	20	None	Barnes	
72.	1946	1946	45	1941-45	Morrow	
73.	1939	1939	90	Not Given	Barnes	
74.	1948	1948	24	None	Barnes	
75.	1940	1940	68	None	Schutt	
76.	--	None	120	None	Barnes	
77.						
78.	1947	1947	60	None	Barnes	
79.	1944	1944	70	1946-47	Barnes	Departmental
80.						

GEORGIA SCHOOL OF TECHNOLOGY
ATLANTA, GEORGIA

DEPARTMENT OF
INDUSTRIAL ENGINEERING

Dear Sir:

Your cooperation is requested in a study we are making of the training procedures used in motion and time study at the college level and also as done in industry.

Information as indicated on the enclosures is requested. With this information we shall attempt to determine the differences and similarities that exist in the techniques and facilities of laboratory training in motion and time study. We are especially interested in any special or unique procedures or facilities which might have more extensive application.

The results of the study will be published or otherwise made available for those who contribute information. Any cooperation that you can give will be fully appreciated, and any suggestions or comments you wish to offer are solicited.

Very truly yours,

Joseph S. Dwyer
Assistant Professor

JD/f
Enc.

EXHIBIT 1

LETTER AND QUESTIONNAIRE
SENT TO UNIVERSITIES AND COLLEGES

Return this questionnaire to-- Joseph S. Dwyer
School of Industrial Engineering
Georgia Institute of Technology
Atlanta, Georgia

Name of School _____ Dept. _____

Information Given By _____ Title _____

When was motion and time study first given as a course in your school? _____

Do you give laboratory training in motion and time study? _____ First Given? _____

What is the total number of students taking courses in motion and time study in one school year? _____

Have you ever given special industrial courses in motion and time study? _____
When? _____

For the following list of equipment indicate with a check mark those which are regularly used in motion and time study instruction or laboratory.

1. STOP-WATCHES: Dec. Min. ____; Dec. Hr. ____; Second ____.
2. MOTION PICTURE PROJECTORS: Silent ____; Sound ____; Constant Speed (Special) ____.
3. MOTION PICTURE CAMERAS: Spring Driven ____; Constant Speed (Special) ____.
   FILM SIZE: 8mm ____; 16mm ____.
4. STILL CAMERAS (list sizes) _____
5. SPECIAL TIMERS: Microchronometer or wink counter ____; Marstochron ____;
   Kymograph ____; Others (describe) _____
6. TOOLS: Hand tools ____; Hand power tools ____; Power wood-working tools ____;
   Power metal-working tools ____; Others _____
7. OTHER EQUIPMENT (describe) _____

EXHIBIT 1 (Continued)

LETTER AND QUESTIONNAIRE
SENT TO UNIVERSITIES AND COLLEGES

On the accompanying forms, information pertaining to the undergraduate course or courses in motion and time study is requested. If more than one course is given in motion and time study, give information for the courses that the student would take to get the most thorough training in motion and time study.

School _____

Course Name _____ Course No. _____

Hrs. Credit, Semester/Quarter _____ Text Used _____

Manual Used _____

Average No. Students in Theory _____ In Laboratory _____

Hrs. Per Week in Theory _____ In Laboratory _____

Give the following information relative to laboratory activity:

Lab. Period No.	Laboratory Activity Description (Such as "Stop-watch observation practice, snap-back and continuous.)	Remarks (Equipment used, work required of student, type of operation, etc.)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

EXHIBIT 1 (Continued)

LETTER AND QUESTIONNAIRE SENT TO UNIVERSITIES AND COLLEGES

GEORGIA SCHOOL OF TECHNOLOGY
ATLANTA, GEORGIA

Dear Sir:

Would you help us in a study we are making of training procedures used in motion and time study? We know that after a student has graduated and starts to work as a motion and time study analyst, he usually must be given additional training. We are trying to find out how we can improve our instruction so that the student will be more effective when he comes to you.

If you now conduct any training in motion and time study, you can give us information which will be very helpful. We are interested in any information relative to motion and time study training whether it is for the recently graduated student, the non-college man, or the time and motion study man who has regularly been doing this type of work.

The information we would like to have is, firstly, a copy of any outline or description of any courses that you may give, and, secondly, the answers to the enclosed questionnaire. The name of your company will not be identified in any way with the information that you should give us for this study.

Your help in this study will be fully appreciated, and any comments or suggestions are solicited.

Sincerely yours,

Joseph S. Dwyer
Assistant Professor
Industrial Engineering

JD/f
Enc.

EXHIBIT 2

LETTER AND QUESTIONNAIRE
SENT TO INDUSTRIAL ORGANIZATIONS

Return questionnaire as soon as possible to--
Joseph S. Dwyer
Industrial Engineering Department
Georgia Institute of Technology
Atlanta, Georgia

COMPANY _____

ADDRESS _____

INFORMATION GIVEN BY _____ TITLE _____

I. Do you have any type of classroom or group training for individuals who are just entering or who are already doing motion and time study work? YES ☐ NO ☐

II. Indicate whether you have any form of group training for the following individuals:

(A) The recent college graduate who has had instruction in motion and time study in school and who is entering motion and time study work. ☐ ☐

(B) The man who is not a college graduate and who is entering motion and time study work. ☐ ☐

(C) The man who is not a novice but regularly does motion and time study work. ☐ ☐

II. If question II was answered "yes" for individuals "A" and "B", is this training the same for these two individuals, or is it different? Same ☐ Different ☐

IV. Indicate the primary purposes of any training given to individuals "A", "B", or "C" of question II:

	INDIVIDUAL A	B	C
(1) To acquaint the individual with the company's general policies and procedures.	☐	☐	☐
(2) To instruct the individual in the basic principles of motion and time study.	☐	☐	☐
(3) To instruct the individual in the techniques and procedures of motion and time study as developed and used by your company.	☐	☐	☐
(4) To instruct the individual in advanced techniques or specialized techniques of motion and time study.	☐	☐	☐
(5) (Others) _____	☐	☐	☐
(6) _____	☐	☐	☐

V. In the training for individuals "A", "B", and "C", which is given the most emphasis--the techniques of motion study or the techniques of time study.

Motion study emphasized	☐	☐	☐
Time study emphasized	☐	☐	☐
No difference	☐	☐	☐

EXHIBIT 2 (Continued)

LETTER AND QUESTIONNAIRE SENT TO INDUSTRIAL ORGANIZATIONS

VI. For the following list of subjects indicate which subjects are included in the training for individuals "A", "B", and "C". In column "D" indicate which subjects you feel should receive additional emphasis in motion and time study instruction at the college level:

	INDIVIDUAL			
	A	B	C	D
(1) Process analysis				
(2) Operation analysis				
(3) Micromotion analysis				
(4) Motion picture photography				
(5) Stop watch reading				
(6) Performance rating or leveling				
(7) Fatigue allowance determination				
(8) Personal allowance determination				
(9) Delay allowance determination				
(10) Standard data (formula) application				
(11) Standard data (formula) development				
(12) Standard motion time application				
(13) Standard motion time development				
(14) Work assignments--automatic machines, etc.				
(15) _____				
(16) _____				

VII. Indicate which of the following devices is used in motion and time study work or training in your company:

	USED	NOT USED	EXTENT OF USE
(1) Motion pictures--			
(a) For micromotion analysis			
(b) For process analysis			
(c) For operator training			
(d) For standard procedures			
(e) For performance rating training			
(f) _____			
(2) Timing devices--			
(a) Stop watch			
(b) Marstochron			
(c) Kymograph			
(d) _____			

(3) Other devices or equipments _____

_____

_____

_____

_____

_____

(Note--If you have developed any special equipment or facility for use in motion and time study work or training, we would appreciate having a description, photograph, or any other information about it

EXHIBIT 2 (Continued)

LETTER AND QUESTIONNAIRE
SENT TO INDUSTRIAL ORGANIZATIONS